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Diesel Engine Pumping Station

GLADSTONE DOCK, LIVERPOOL, HAS WORLD'S MOST POWERFUL INSTALLATION OF ITS TYPE. BY FREDERICK C. COLEMAN

IT WILL be remembered that in July, 1913, His Majesty the King took advantage of one of his industrial visits to Lancashire to open the new Gladstone Dock, Liverpool. At that time, the pumping machinery was not installed, but has subsequently been completed and is in successful service, and by the courtesy of Thomas M. Newall, the chief engineer of the Mersey Docks and Harbor Board, the installation is illustrated here by means of the most powerful pumping plant driven by Diesel engines. There are 5 units, each composed of a 54-in. Worthington centrifugal pump direct-connected to a 1000-b.hp. Carels-Diesel engine. The duty required of the pumps is to empty the dock of its whole contents amounting to about 44,000,000 gal., say, 200,000 tons, of water on an 18-ft. tide—in 2½ hr. Each pump is provided with 54-in. discharge branches, with 2 suction branches, each 40 in. diameter. The mean capacity of each pump is not less than 58,000 gal. per min., and

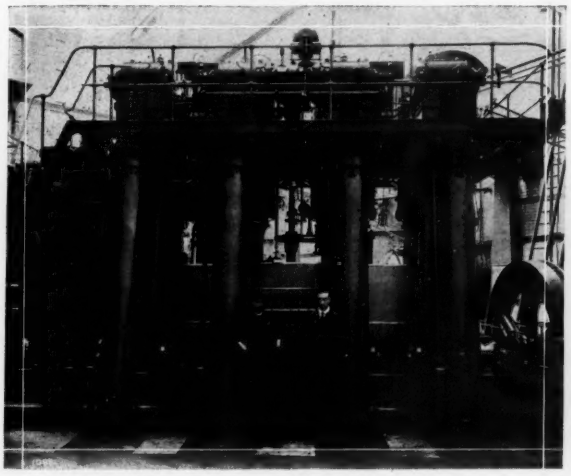


FIG. 3. SIDE VIEW OF ENGINE

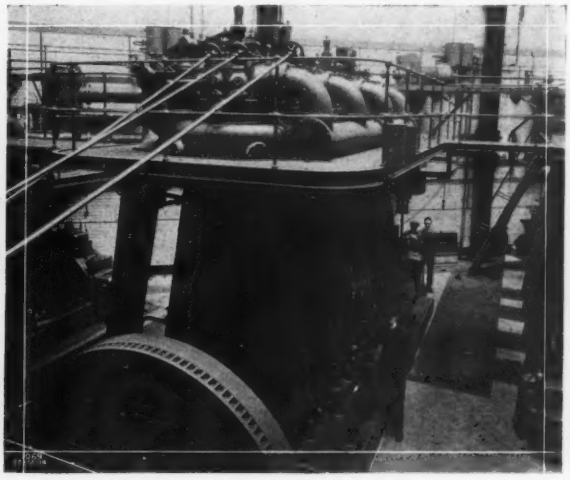


FIG. 4. END VIEW OF ENGINE

photographs. The Gladstone Dock has a length of 1050 ft., a width at entrance of 120 ft., while the entrance sill is laid 15 ft. below low tide level. The entrance of the dock is closed by a sliding caisson, which maintains the water in the dock or excludes it therefrom, according to the nature of the duties of the dock for the time being. In order that the dock may be rapidly cleared of water when required for use as a graving dock, exceptionally powerful pumps are required.

This installation is of more than ordinary interest by reason of the fact that the pumps are driven by internal combustion engines, and this takes rank as the pumps are designed to work against a maximum static head of 48 ft. when running at a speed of 180 r.p.m. Two of the engines and pumps are also designed so that they are able to pump under exceptional circumstances against a maximum head of 61 ft. when required for drainage purposes. Two others are arranged so that, if necessary, they can pump water from the entrance channel into the dock when as a wet dock and so provide against any shortage of water in the dock through leakage or otherwise. The engines are of vertical 2-cycle, 4-cylinder Diesel type, built at the

works of Messrs. Carels Freres, of Ghent, to the order of the Worthington Pump Company, Ltd. Each of these engines is capable of developing its normal output of 1000 b.hp. and an overload of 10 per cent for 2 hr. when running at 180 r.p.m. Each of the cylinders has a diameter of 20 in., the stroke of the pistons being 26 in., and when the engines are developing 1000 b.hp. at 180 r.p.m., the mean effective pressure is 6.75 atmospheres.

These engines mark a distinct departure in Diesel engine design, inasmuch as they are fitted with marine type crossheads, similar in design to those so well known

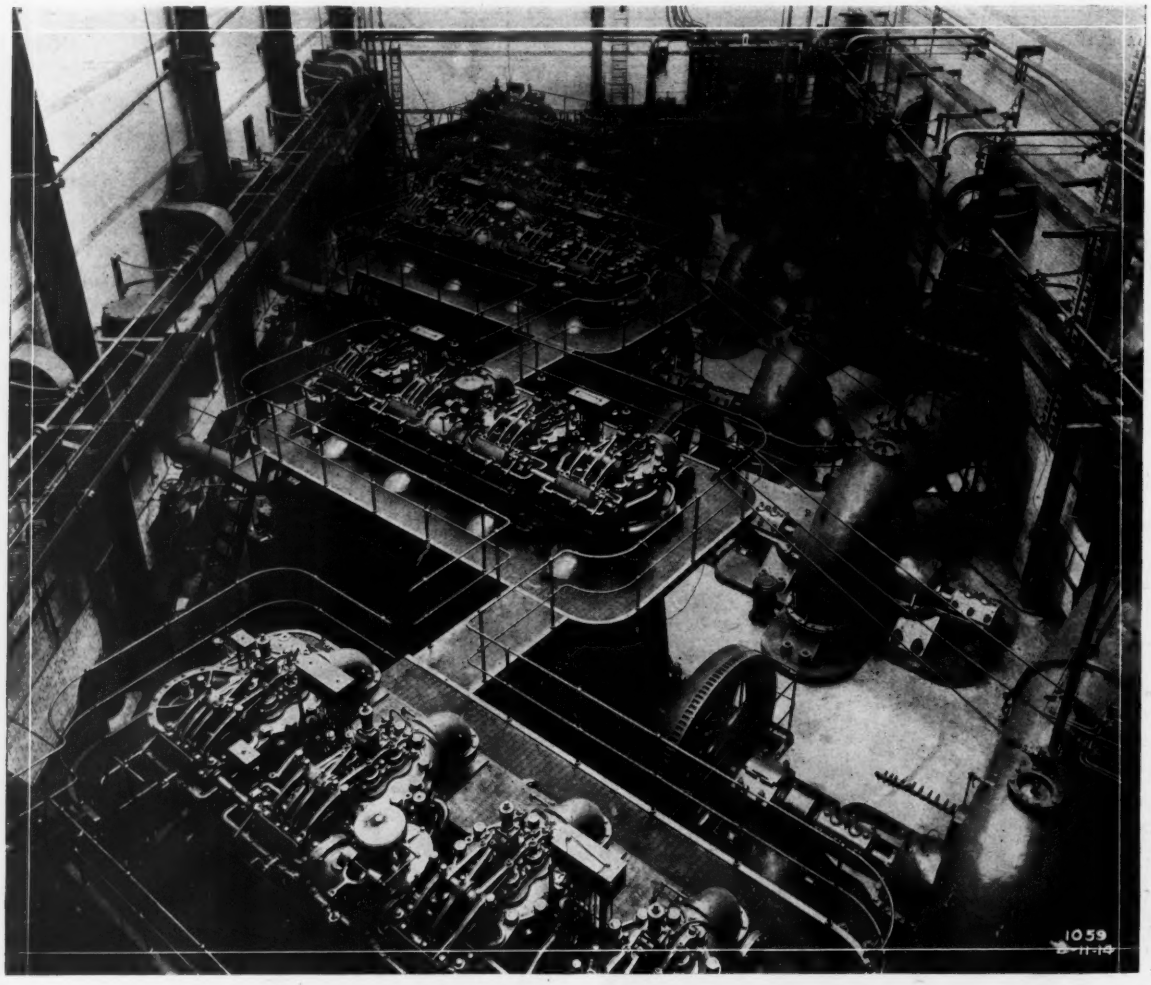


FIG. 1. GENERAL VIEW OF PUMPING ENGINES AT GLADSTONE DOCK

to the steam engineer, instead of the usual "trunk" type piston. These crossheads run in efficiently water-cooled guides, which thus take the thrust that formerly came on the side of the engine cylinders. This allows much greater clearance to be given to the pistons, and, further, eliminates risk of seizure. Two fuel pumps are employed, each pump having 2 plungers, one for each cylinder. Distributors are not used, fuel being delivered direct to each fuel valve. Both pumps are uniformly controlled by the governor, which is placed between the 2 middle cylinders. The governor is of the Hartung type, and is driven from the vertical shaft in the usual manner. The scavenge pump delivers air at about 5 lb. per sq. in. pressure to the scavenge valves, 4 of which are situated in each cylinder cover. These valves are driven in an ingenious manner, 2 valves being operated from one lever. The high-pressure air pumps are of the quadruplex water-cooled type, delivering air for fuel-injection and starting purposes. This air is first delivered to the injection vessel, one of which is supplied with each engine. The overflow from this injection vessel is sufficient to keep fully charged 2 steel vessels used for starting purposes, the average pressure of these receivers being about 65 atmospheres. These air-vessels are inter-connected with each other and with an auxiliary motor-driven compressor. This compressor is capable of charging any of the starting air-vessels up to 600 lb. per sq. in. in 4 hr. It will thus be seen that the contingency of any engine not being able to start through loss of air has been amply provided against, as each engine will have the other engine's supply of air to draw upon, in addition to the auxiliary compressor, in the extremely unlikely event of the entire supply failing.

Owing to the water level being considerably above the engine-room level, the air vessels are supported in a special cradle, and do not touch the side or bottom of the pit in which they stand. This arrangement also allows them to be readily withdrawn for periodical painting.

Noise in the engine-room which might be occasioned by the inrush of suction air, has been provided for by the use of suction-air silencers. These have been arranged on the engine-room wall, and the whole of the air supply to each scavenge pump passes through these silencers before going to the engine. In order that the scavenge air shall not be supplied to the cylinders at too high a pressure, blowoff valves are arranged in the scavenge-pipe collector; these valves opening at 8 lb. per sq. in.

The exhaust leaves the engines through ports in the side of the cylinders and is then taken through water-cooled down-take pipes to a collector-pipe situated below the engine-room floor. From the collector-pipe, the exhaust is taken up the engine-room wall to the silencers which are situated 50 ft. above; i.e., on the ground-level, and from there to an outlet well above the roof of the building. It will thus be seen that the exhaust pipe is a very long one, and special precautions have, therefore, been taken adequately to provide for expansion and contraction. Under each engine cylinder is a ring for collecting the cylinder lubricating oil and to prevent it from mixing with the oil in the crank-pit. The oil from the collecting ring is taken away to a separate pump, and in this manner the oil consumption can be economically adjusted. A speed-varying gear is fitted to each of the engines, in order that the speed may be regulated between 180 and 198 r.p.m., this variation being necessary to deal with the varying heads the pumps have to operate against. Piston-cooling pumps are of the "plunger-displacement" type, and driven direct from the engine crosshead, the water being forced through the center of the gudgeon pin up the piston-rod.

Three Worthington motor-driven cooling-water pumps have been supplied, 2 of which are capable of dealing with all cooling water required for the jackets, pistons, exhaust pipes, crosshead guides, etc., the remaining set acting as a stand-by. The whole of the cooling water from the engines runs into a sump situated in one corner of the engine-room, from which the pumps force it to the top of the cooling tower. The water, after gravitating through the cooling tower, flows through the cylinder jacket under a practically constant head. This method of cooling has been found by the makers to be most satisfactory. The cooling tower, supplied by the Midland Engineering Company, Ltd., of Smethwick, Birmingham, is of the natural draft type, and is 60 ft. high, having a base 36 ft. by 20 ft.

The oil fuel is stored in 2 separate fuel tanks, each one 25,000 gal. capacity, situated outside the engine house. Two intermediate fuel tanks, each of 500 gal. capacity, are situated in the engine-room, and the oil from the main fuel storage flows into them by gravity. These oil tanks are surrounded by a gallery, so that easy access to the valves, etc., on the tanks can be obtained.

Each pump unit is constructed in halves, the discharge branch leading from the upper part of the casing. The impellers are of cast iron, carried on Siemens steel shafts. The pump bearings are of the ring-oiled type, and are entirely separated from the stuffing-boxes, so that, not only is continuous lubrication ensured, but the entrance of any foreign material from the stuffing-box to the bearing, is entirely prevented. On the discharge side of each pump is provided a 54-in. sluice valve, operated by a hydraulic cylinder, working at a pressure of 800 lb. per sq. in., the water under this pressure being taken

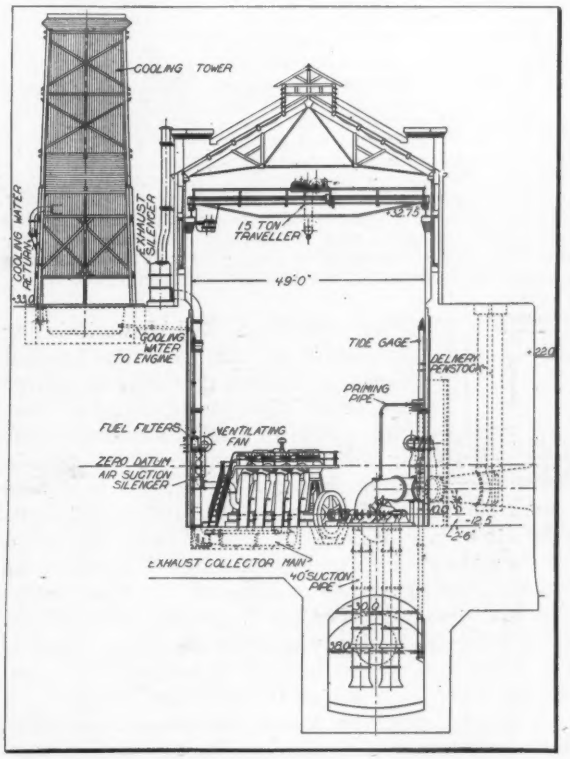


FIG. 2. ELEVATION SHOWING GENERAL ARRANGEMENT OF PLANT

from the Mersey Dock Board's hydraulic supply station near by. In order to ensure the starting of the pumps under any conditions of lift, priming air pumps have been provided of the duplex single-acting Edwards type. These pumps are driven by electric motors of such capacity as to evacuate the main pumps quickly when required. The control of the priming and hydraulic valves is so arranged that the attendant on the engine platform can at will manipulate either of these systems, and will be able to start any unit without leaving the engine platform. The whole of the auxiliary plant is electrically driven by motors supplied with current from 440-v. direct-current local supply, all the auxiliary pumps being arranged in the southeast corner of the engine-room, underneath the switchboard platform. The whole area of the engine house is commanded by a 15-ton overhead traveling electric crane, which was used for erecting the pumping machinery, and the engine-house is ventilated by 6 electrically-driven Davidson Sirocco fans drawing air from above the quay level, and discharging it near the floor level.

Handling the Ashes

FORMS OF ASHPITS, STORAGE AND CONVEYING METHODS. BY R. A. LANGWORTHY

R. A. LANGWORTHY graduated from Pratt Institute, Brooklyn, N. Y., spending 2 yr. after graduation in power plant design for W. E. Baker & Co., then 3 yr. with Ford, Bacon & Davis, of New York City, as designer and construction superintendent on electric lighting and railway power plants. The 4 yr. following, he was construction superintendent and, also, in charge of operation of a system of steam and water power plants for Meikleham & Dinsmore, covering a large syndicate of electric plants and exhaust steam heating, acting for a year afterward as general manager for this system, an then spending a year in consulting work on steam power plants. For the past 18 months, he has been engaged on power plant layouts and consulting service for boiler room and stoker work, in connection with the installation of Taylor stokers, made by the American Engineering Co.

IN DOING SOME SPECIAL work during the past 18 months, the writer has had occasion to inspect the plans of a large number of boiler plants, many of them being plants of small or moderate size, say 2500 hp. and under. The defects in design shown in these plans have been remarkable from the fact that several fundamental faults seemed to be present in the majority of them. The plant layouts certainly indicated either a lack of study of the subject or an ignorance of some of the requirements of a well designed boiler plant. It is hoped that the points considered below will bring the matter home to some of the men who are considering new plants or plant extensions.

Without doubt, the 2 most common defects which occur in boiler room layouts are lack of proper basement and adequate facilities for the handling and disposal of ashes. These 2 propositions are interlinked to such an extent that they should be considered together.

The modern tendency, even in small plants, is toward mechanical stokers and the forcing of boilers to higher capacities than rating. Both of these factors are steps in the proper direction for ultimate plant economy, but they aggravate the situation as regards handling ashes. The quantity of ash is increased and often it is in the form of large clinkers which are difficult to handle.

The best method of handling ashes from the boiler room to the outside storage, is on tracks in industrial cars propelled by hand. It is an advantage to install the track with a slight down grade in the direction of movement of loaded cars, to assist in starting and running them out of the boiler plant. There are so many different types of cars on the market, that no difficulty should be experienced in obtaining the correct type to suit the plant conditions. Suction ash systems are effective, but likely to be high in first cost and require considerable power to operate. Bucket, scraper, screw and other conveyors in handling ashes are subject to heat, dust and clinkers in the ash which cause abnormal wear.

The basement under the boiler plant is most important and should be omitted only after careful study has developed some strong reason for dispensing with it. The writer has in mind 3 plants, one of them over 8000 hp., in which it became imperative to provide the basement after the plant was completed and in operation, entailing, of course, a much greater expense than it would have cost to provide it when the plant was built. In plant extensions, when the existing plant has no basement, one should be provided for the extension where possible.

Headroom in the basement is often an item for discussion. It should never be less than 12 ft. (15 ft. is preferable). The usual argument against a basement is the expense involved; but, in considering the subject, the operating expense of different layouts should also be taken into account. A proper basement will always lead to considerable reduction in the ash-handling expense and also in the maintenance charges on auxiliary equipment, due to elimination of considerable dust and dirt. Ash dust is fine and penetrating and will rapidly cut and score any moving parts.

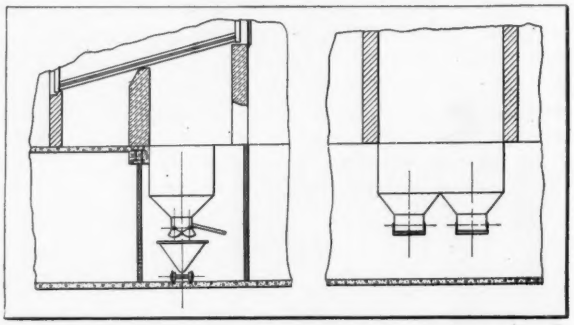


FIG. 1. LARGE CAPACITY ASH HOPPER FOR DEEP BASEMENT; ASH TUNNEL ENCLOSED

When a basement is provided, the boiler feed pumps, blowers and other auxiliaries, together with their unsightly piping, may be located there. In case such machinery is placed in the basement, the ash-handling equipment should be separated from the main section by means of thin partition walls to keep away the dust and dirt.

ASH HOPPERS

IN LOOKING over ash hopper designs one is struck by the fact that the man responsible for some of them must have had a poor conception of the amount of ashes a good, healthy boiler will make. In planning the hopper, calculate the amount of coal to be burned in 24 hr. and be liberal in your figures. The ash should be assumed as, at least, 10 per cent of the coal and the writer has known of cases where the ash amounted to 33 per cent with poor grade anthracite. Make the hopper deep enough to keep the hot ashes away from the grates when the fire has been dumped. More grate and stoker parts have been burned out by heat from the ashes beneath than from the actual fire.

Ash hoppers are of numerous forms and their size and design will depend largely upon the local conditions.

Three good forms are shown in Figs. 1, 2 and 3. The hoppers are illustrated merely to indicate types and are susceptible of modification to suit the plant under consideration. The hoppers should always be of as large capacity as possible, so that they need not be emptied every time the fire is cleaned. They may be of steel, lined with concrete or brick, or of reinforced concrete, as the designs shown lend themselves readily to either form of construction.

Figure 1 shows an excellent hopper of large capacity. Its depth will depend upon the available headroom and this should be utilized to a maximum. The duplex gates should not be less than 24 in. square and if the hopper is wider than about 6 ft., 2 gates should be used. The figure shows a full basement with thin partition walls to keep the dust and dirt from the remainder of the space. A tunnel might be used with this scheme, to save excavating the rest of the basement space; but if this is done, especial care should be taken to provide adequate ventilation. With the construction of Fig. 1, little handling of the ashes is required. The car should be of large capacity and is run under the gates, filled and wheeled out.

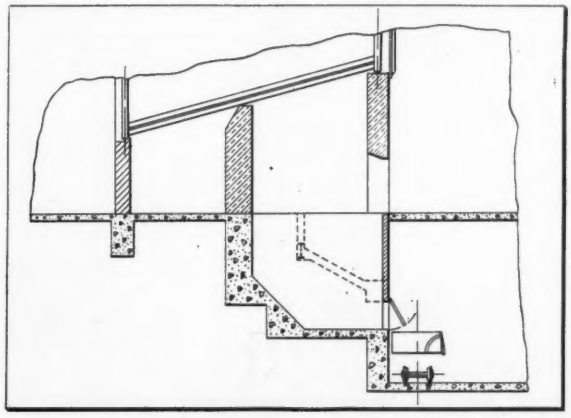


FIG. 2. ASH HOPPER UNDER ROOM WITH NO BASEMENT; SIDE DISCHARGE TO ASH TUNNEL IN FRONT

Figure 2 shows another good type of ash hopper. It may be used as shown, which requires the excavation of a tunnel in front of a single line of boilers, or of the space between the fronts of a double row, or may be hung from the steelwork in a full basement. The dotted lines indicate the construction when used with stoker equipment. With this form of hopper, the ashes must be raked into the car, so that tunnel construction should be made wide enough to allow a man to work handily. This construction will call for less depth of excavation than that shown in Fig. 1, but requires that a man handle the ashes from the hopper into the car.

The construction shown in Fig. 3 involves a tunnel at the rear of the boiler, or may be used as a suspended hopper in the basement where the boiler settings are carried on the first floor steelwork. In the latter case, it leaves the center of the basement free for boiler feed pumps, air ducts, blowers, piping, etc. Some work will be required to get the ashes into the car, but it consists mainly in using a bar to keep them flowing and is an easier proposition than Fig. 2. Figure 3 may be used without the full basement by excavating only for the ash tunnel and hopper.

Figure 4 illustrates a very ingenious scheme which recently came to the notice of the writer. An ample water supply was available at the plant and the location was such that the unlimited space was available below the basement level for a dump. When the time came for cleaning, the ash hopper doors were opened and a strong stream of water turned in through several pipes at *A*. The door, *B*, at the bottom of the hopper extends all the way across. The water, with some assistance from bars, carried the ashes into gutter *C*, which was of liberal size and properly pitched toward the dump. The whole scheme is simple and effective, but requires considerable water.

From the various figures shown and the description given above, some idea of the requirements of a good ash hopper may be gathered. Make the hopper large enough and all parts heavy. Never use sheet steel in direct contact with the ashes; cast iron is best.

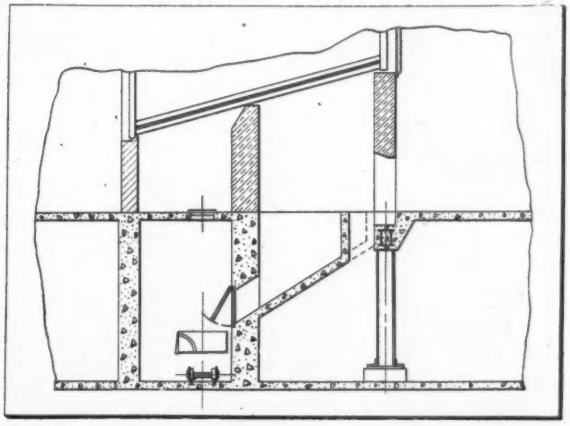


FIG. 3. SIDE DISCHARGE HOPPER TO REAR ASH TUNNEL

The above applies to the removal of the ashes from the hopper. Their handling from this point on depends upon the ultimate disposal of them. In case they are used for filling in around the plant property, the industrial truck may be run direct to the dump. When the dump is some distance from the plant, several cars may be hauled at once by a mule. The writer distinctly remembers having purchased a secondhand mule for this very service, which did excellent work for 8 yr. before he died. The first cost of the mule was $20.

Handling and Disposal

Most plants are not so fortunate, however, as to possess a permanent dump. The ashes must be removed by railroad or wagon. In this case, an elevated hopper must be built of concrete, or steel construction lined with concrete. Concrete lining, when used, should be made of Portland cement, sand, and fine, clean cinders and should have expanded metal reinforcing throughout to prevent cracking. The hopper should be so located as to discharge either into railroad cars or wagons through suitable chutes. The ashes may be dumped from the industrial cars into a good sized concrete hopper and elevated to the overhead hopper by means of an automatic skip bucket, driven by a small motor. The

necessary wetting down of the ashes should be done at the time they are raked into the cars from the hoppers under the boilers. Water piping and hose at handy locations will assist materially.

The system described above of ash cars in basement and skip bucket to overhead hopper, is probably the best that can be devised for small plants and has the following decided advantages:

1, Low first cost; 2, simplicity; 3, durability and low maintenance charges; 4, flexibility; 5, small power required to drive skip bucket motor.

Where the first cost is not prohibitive, the suction system of handling ashes has many advantages. It is simple, durable and occupies much less space in the plant itself than any of the other systems. It requires considerable power; but it is not in use for many hours a day, so that this may not be a serious consideration.

Gates and Valves

Judging from some examples which are at large, a few words on gates and valves for ash hoppers will be much to the point. The flat, sliding gate should never be used for ashes or coal, especially for ashes. The

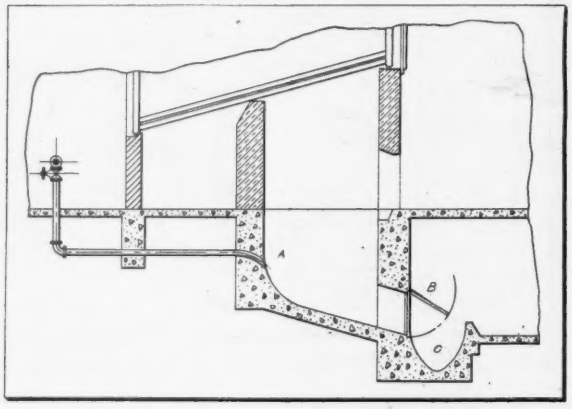


FIG. 4. HOPPER AND GUTTER FOR FLUSHING ASHES TO DUMP

writer has seen numerous designs of flat sliding gates, some of which were very clever on paper, but has yet to see one which gave proper operating service. The feature which apparently appeals to some engineers is the saving in space, allowing the basement depth to be cut down to some extent. This is the only advantage which the slide gate possesses and is not sufficient to warrant its adoption. Most of the designs of slide gate are more expensive than other types and are not sufficiently rugged. After a short time in actual use they are rendered worthless by the heat and dirt in the ashes and the rough handling they receive in use.

The most satisfactory all-around gate for ash hoppers, bins, etc., is some form of cast iron, single or duplex, operated by links and lever. There are many such standard gates on the market which can be purchased at a reasonable price. Cast iron is best adapted to resist the heat, dirt and chemical action. The valves are easily operated by one man, are simple in construction, rugged enough to stand hard usage and form a positive cutoff for the ashes.

Another good form of gate is that shown in Figs. 2 and 3. It should be made of cast iron, heavy and well ribbed and provided with some simple form of latch on both sides near the bottom. In some ash pits using this form of gate, the opening is made continuous across the entire width. In case this is done, the swing gate should be made in sections of not over 36 in. long to prevent troubles due to warping and to keep down the weight.

Remember that any equipment in a boiler plant will receive hard usage and very little attention or repair. It should, therefore, be simple, rugged and as nearly fool-proof as possible.

Any reader who is considering plant construction work will do well to give to the ash handling system the attention it deserves. Put in that basement which seems unnecessary, Mr. Man, and you will not regret it.

Furnaces for Waste Gas or Coal

Novel Arrangement for Automatically Changing from Gas to Coal as Fuel

IN many industrial plants, the service performed by the power plant is of a highly special character, so that the plant equipment requires individual study with special design. Such a condition has been met at the Wisconsin Steel Co.'s Works in South Chicago, Ill., and through the efforts of the Chief Engineer, A. U. Leonhauser, an installation has been worked out which is novel in some respects and has solved one of the great difficulties met in steel plants, i.e., the economical use of waste furnace gases and coal as an auxiliary.

This plant is one of the older steel works in the South Chicago district, being started as part of the Deering Harvester Co.'s Works, but when the International Harvester Co. was organized, this plant was taken over by that company and now furnishes all the bar steel used by the various branches of the Harvester Co. besides furnishing a large amount for the commercial trade.

The plant consists of 3 blast furnaces, a Bessemer steel converter, a blooming mill, 3 merchant bar mills, and a shafting mill with all accessories to operate them. All power used is developed at the works, the fuel used in the boilers being for the most part waste gases from the furnaces.

A study of the conditions of this plant developed that, although the boilers installed operated efficiently on the waste gases when there was sufficient to supply the needs, at times it became necessary to use coal as an auxiliary fuel in order to supply sufficient steam for the needs of the plant. At these times, the boiler furnaces were fired with coal in addition to what gas they received; but this method proved impracticable, as it was impossible to regulate the air supply so as to secure proper combustion of both gas and coal.

The problem has been solved by the installation of 4 new boilers which are designed to burn either gas or coal efficiently with an automatic arrangement for cutting off the gas supply and starting the stokers when it is necessary to burn coal.

Each of the new boilers has a rating of 518 hp., and furnishes steam at 150 lb. pressure and 100 deg. super-

heat. They are Ross vertical water-tube boilers, made by the Lyons Boiler Works, which consist essentially of a transverse upper or steam drum, a lower or mud drum connected by tubes of various curvature to the upper drum, and a feed water header placed behind the steam drum but partially outside the setting, connected by a row of tubes to the mud drum and by a single pipe to the steam drum.

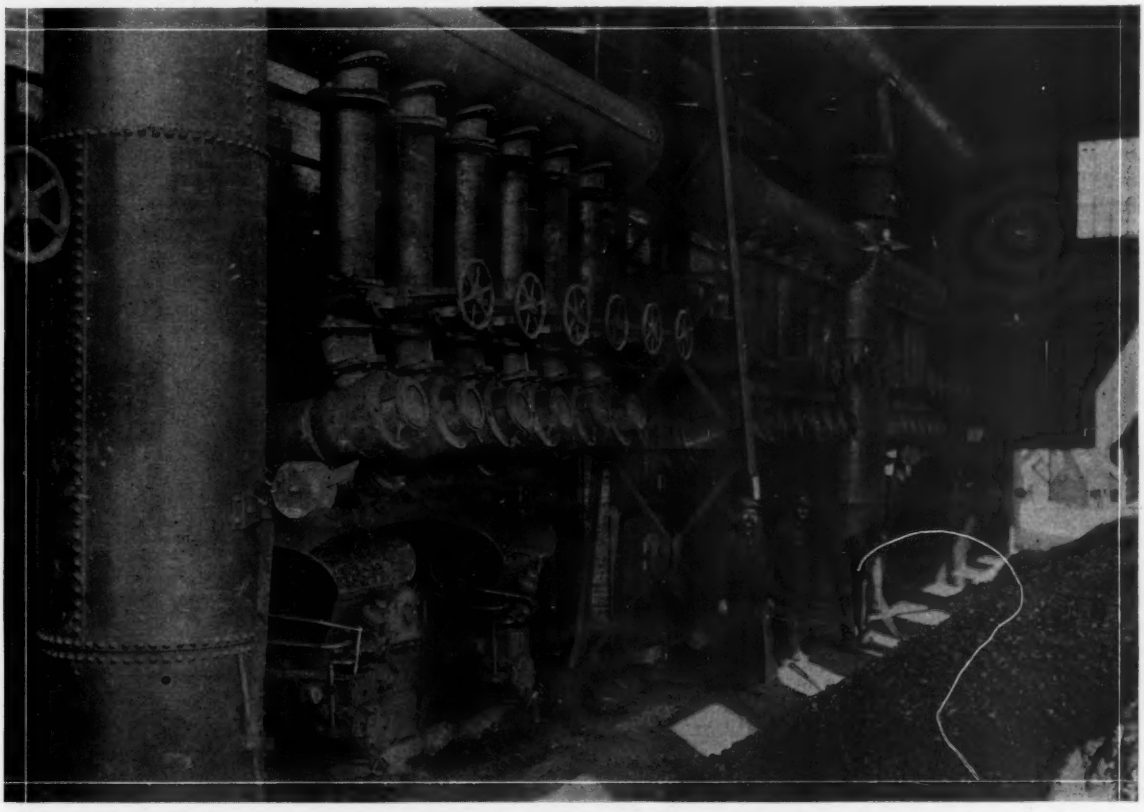
The baffling is arranged for 3 passes of the gases, and for each 2 boilers is a reinforced concrete stack 150 ft. high. From a platform over the furnaces all valves but the blowoff for the operation of the boilers are accessible.

Each furnace has 6 Birkholz gas burners and 2 Combustion Engineering Co.'s Type E stokers. The gas burners are quite similar to the Bunsen burner, but the outer end is covered with a glass plate through which the appearance of the fire can be watched without opening the furnace. Gas comes to the boilers direct from the blast furnaces, except for the intervention of dust collectors, and reaches the boilers at a temperature of about 250 deg. under a pressure of 2 to 3 in. of water. The heat value of this gas averages about 84 B.t.u. per cu. ft., which, on account of the efficient blast furnaces, is low, even for waste gases.

The stokers are, in all important respects, similar to that described on page 511 of the May 15, 1915, issue, and are automatically controlled by a McDonough regulator, which also controls the speed of the forced draft fan.

Probably the most interesting feature of this plant is the automatic system for changing from gas to coal for fuel, and vice versa.

The entire steam generating equipment consists of 25 350-hp. and 6 250-hp. Stirling boilers, in addition to the new equipment of 4 518-hp. boilers. All the old boilers are operated on waste gases only. At times, the demand for steam is beyond that which may be developed from the gas that is available, and as it is impossible to force the boilers with the gas, when the steam pressure falls to a certain limit, a Mason regulator closes the butterfly valves in the gas pipes leading to the 4 new boilers, and at the same time the McDonough regulator starts the stokers and the fan engine in the new plant.



VIEW IN NEW BOILER ROOM OF WISCONSIN STEEL CO.

By this arrangement, the new boilers can be forced to 200 per cent of their rating, and raise the pressure in the steam piping system, which is connected to all boilers. Then when the proper pressure has been reached, the automatic devices again act to change back to the gas fuel. By this arrangement, the 4 new boilers take care of all fluctuations in steam pressure and gas supply; at the same time all fuel is used in the most economical way.

"Highest economy in the modern steam power plant is to be gained only through an accurate knowledge of all conditions as they exist throughout the station, both as to materials used in the production of power and as to condition ond performance of equipment."—Tenney.

Fuel Oil Burning

THEORY OF THE PROCESS; DESCRIPTION OF READILY MADE EQUIPMENT; REQUIRED CARE IN OPERATION. BY U. BACHMAN

MY first experience in the use of crude oil as fuel, was in Alaska, where the owner of a large hardware store asked me if I could devise a way to burn successfully this oil in a large cast-iron stove used to heat the store. The materials given me were a water barrel, a water tank, a garden hose, a coal-oil can and pipes and fittings. The usual appliances for coal-oil burners are: high-pressure steam in power plants, air pumps in low-pressure steam heating plants; oil, air or steam, pressure gages and pressure regulators, pressure-reducing valves; steam, air and oil nozzles; heating devices for oil and air appliances for conveniently starting the burner and a number of other auxiliaries of minor importance.

It will thus been seen that I was rather up against it in the supply of proper material.

I first made a boiler, as illustrated in Fig. 1, of about 8 ft. of ¾-in. pipes, some return bends and elbows. This I placed in the rear part of the stove. I then connected

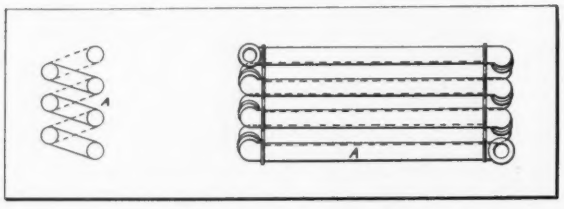


FIG. 1. LONGITUDINAL AND END VIEW OF BOILER COILS

it with an air tight water tank, B, by a ⅜-in. water supply pipe, E. In this pipe I put the regulating valve, D. The water tank, B, was then connected with the water barrel, G, located about 25 ft. above the floor, by garden hose, F.

The other end of the boiler piping was connected by means of a ⅜-in. pipe acting as a steam outlet to nozzle K at the front of the stove. This pipe is marked H and had a regulating valve, I. About 10 ft. above the floor, I placed the coal-oil can, P, filled with crude oil. From this can I led ¼-in. pipe O into the front of the stove through the same opening as pipe H. In pipe O is regulating valve C. Nozzle K was constructed as follows: I filed about ⅛ in. off from a ⅜-in. pipe plug, as shown in Fig. 3. On the smaller end I filed more than on the wider end and then screwed it into a ⅜-in. pipe sleeve as shown in Fig. 4. The reason I filed more off the narrow end was that by screwing it more or less into the sleeve I increased or decreased the size of the opening, which was made flat in order to give to the flow of steam a fanlike shape. Connection sleeve marked N with plug L, I screwed onto the end of pipe H and directed its course toward coils A.

Onto the top I fastened the end of oil pipe O and rested this nozzle on the trough-shaped support, M.

THEORY OF OIL BURNING

BEFORE STARTING to describe the manner in which we operated this burner, I will take up the chemical transformations taking place in the fuel in the process of producing heat. No fuels are inflammable unless some of their ingredients or elements are separated from the rest of them. Different fuels require different temperature for this separation, which is called "decomposition of their elements." For instance, gasoline decomposes under ordinary temperature. It will ignite immediately when brought in contact with fire. You can hold a burning match over a spoonful of kerosene and the kerosene will not burn; but if you soak the burning match with kerosene the heat of the flame will dissolve the union between the elements of the oil and the separated gases

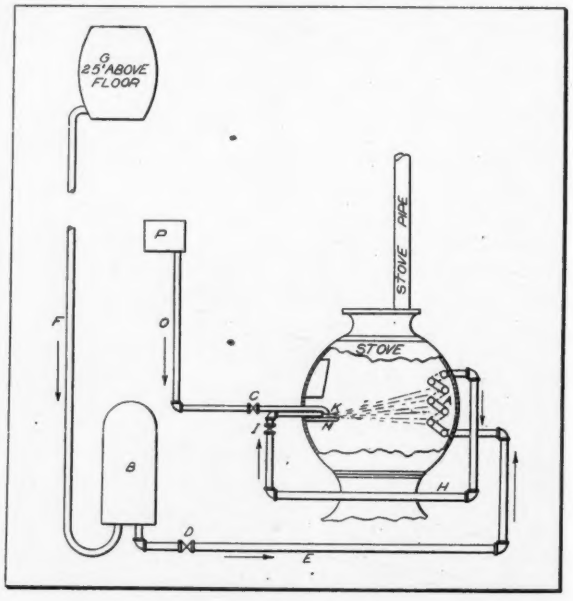


FIG. 2. GENERAL ARRANGEMENT FUEL OIL BURNING EQUIPMENT

will burn. If a house was on fire and you could pour over it crude oil fast enough so the fire had no time to transmit its heat to the oil, you could extinguish the fire. This dissolution of the unions between the elements of the fuel by the heat is the first step taking place when the oil enters the furnace. The fuel consists of the following ingredients: carbon, hydrogen and water. Water is composed of hydrogen and oxygen, and under certain conditions even water plays an important factor in producing heat, as will be shown. The next step is the heat producing process. It is the new union between carbon with oxygen and hydrogen with oxygen. This is derived from the air. These new unions and heat producing processes are vis-

ible by the phenomenon called flame, fire, or glowing carbons; and the operator will soon learn from the appearance of the fire whether or not he gets full value from his fuel. The first thing necessary to effect the decompositions of the elements is heat, and then greater heat, with the addition of more oxygen, effect the new union. The result depends on the proportion present of the 2 requirements. If the flame is white, lively and roaring with no intermingling red points around it and clear air all through the furnace, the heat will be intense. The fireman in his endeavor to get best results has to take into consideration the short space of time in which the 2 chemical transformations have to take place. They have to take place from the time the fuel leaves the nozzle and before it comes into contact with any solid, for instance, the brick wall of the rear of the furnace, unless this wall is in an incandescent state. If it does not do so, the burner is not perfect or the operator is at fault. In describing my second experiment, it will be shown that it is in the power of the fireman to attain this result. I will now describe our experience in the first experiment.

Operation of System

We allowed the water to run from barrel G into water tank H, and from there into boiler, A, and then closed valve I until steam was up. The air in tank B became compressed to about 12 lb., and after operation once had commenced, it automatically replaced water in boiler, and the pressure could never fall below or rise above about 12 lb. As we had no other convenient way to start the burner we had to fire up the boiler with kindling wood. After steam was up we allowed the fuel oil to drop onto the stream of steam coming out of the nozzle. Gradually the force of the steam increased and we supplied more oil and eventually obtained a big, hot, white blast, the roar of which echoed all over the large room.

After observing the operation of the system we walked to the front part of the building, when suddenly the owner went back to the stove and called "come back, the stove is melting." We found the stove looking like the full moon just rising above the horizon on a cloudy night. After it had cooled off I screwed plug L further into sleeve N in the nozzle to decrease the flow of steam and enable the use of less oil and smaller fire, but after some experimenting we found we could not get the temperature high enough to prevent the deposition of carbon and formation of smoke. In order to make the burner work well the fire had to be larger than required and the roar it made would not have been bearable.

My next experiments were made on a low-pressure steam heating boiler.

The boiler in question might have been suitable for coal under a slow draft, but was no good for the purpose of oil burning. Cold air and oil were pumped against the solid brick walls, formed in arches. Instead of having grate holes in the front, these were in the rear of the furnace, thus allowing the fire to blow down through them and into the ash-pit, so that the warm air and a part of the gases were lost through the ash-pit opening. There was a large space behind the bridge wall under the boiler where the air and gases cooled off and were allowed to go up the smokestack unconsumed. The boiler was made up of a number of cast-iron sections so constructed as to be impossible to clean it of scale on the inside and difficult to clean it of soot on the outside.

I first put in a regulator for the flow of the oil between the pump and nozzle and then made a bypass around it and set it so that just enough oil would run through it to keep the fire going without the formation of smoke and settling of carbon deposits. I then adjusted the regulator so as to stop the flow of oil after the steam pressure in the boiler was as high as the heating plant was built for.

Two nozzles were placed under this boiler. I made 2 heating coils of 1-in. iron pipes, return bends and elbows and large enough so that the air pumped through it would become hot enough to decompose the oil into gases as soon as it left the nozzle. These coils I put directly into the furnace but out of the path of the fire. The great quantity of air that was pumped through them kept them from being harmed by the heat. I then connected a large pipe about 6 ft. long onto the top of the boiler. Through this pipe I ran a coil of small pipes and connected it with oil pump on one side and the oil nozzles in the furnace on the other side. The heating system was made for a pressure of about 10 lb. Under this pressure the temperature of the steam is about 240 deg. F. Crude oil, when exposed to a temperature of about 180

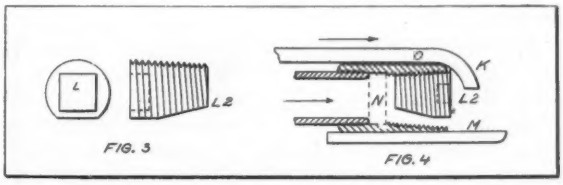


FIG. 3. SPRAYER FORMED BY CUTTING OFF PART OF PIPE PLUG

FIG. 4. DETAILED CONSTRUCTION OF SPRAYER

deg. F., will deposit carbon. Crude oil in this last named coil surrounded by steam at 240 deg. F. no doubt will carbonize if standing still, but in motion might not settle much. This coil might be made of larger pipes than needed in the beginning and can stand some deposit. I believe it pays well to heat the oil to the highest degree allowable and if carbons have deposited to interfere with the flow of the oil, renew the coil. In the nozzle the crude oil had to pass through a small copper pipe 1 ft. long, surrounded by the heated air. It is possible that carbonization might take place in the copper pipe and cause trouble, and it might be a better idea to eliminate this copper pipe altogether. The opening of the air nozzles had to be considerably enlarged on account of the raising of the temperature of the air to such a high degree and the consequent increased volume. If air and fuel is heated to such a great measure there is no need at all of giving the air a great pressure and force against the bridge wall as was proven in this case after the furnace was heated and an intense hot, white and clear blaze issued only a few inches from the end of the nozzle and in a short time brought the bricks of the bridge wall to a white heat. There should not be both cold and hot air blast in the furnace, because the cold air destroys the benefit of the hot air, and the hot air blast will have only ½ as much oxygen as the cold blast on account of the expansion of the hot air in the coil.

The bad effects of cold air on the fire can be noticed when the furnace door is left open and smoke is gradually forming, indicating the interference in the production of the required heat to consume the carbons. The effect on the invisible gases is still worse.

Before this improvement was made the boiler was continually standing in a pool of crude oil. Oil was thrown beyond the bridge wall and against the back wall and burned there with a reddish smoky flame. Some oil ran down the grate holes, formed pools of oil in the ash pit, and burned or evaporated there; chunks of carbon had to be hammered or pounded off the grates every day. This waste stopped after the air and oil were heated and only a small spongy, gray substance formed by impurities of the oil deposited. In the morning after the radiators were once heated and the consumption of steam went down to the minimum the oil consumption became small, consequently the heat in the furnace decreased, the bricks cooled off, carbon deposited and the flames became reddish and smoky. In order to preserve as much as possible the condition the furnace was in when the fire was in full blast, I placed a pile of broken fire bricks against the bridge wall in the path of the fire. The pieces of bricks being small, became incandescent, increased the heat in the furnace and when unvaporized oil was brought in contact with them, it was consumed with a hot flame.

For obvious reasons, an internally fired boiler with return flues is far superior to other types of boilers. A boiler of this kind can be kept cleaner. When it is considered that $\frac{1}{8}$ in. of scale or soot prevents more heat from being transmitted to the water than a $\frac{3}{8}$-in. boiler plate, it is no wonder that an abnormal amount of crude oil may be consumed, notwithstanding any improvements in the furnace.

Development of Hydro-Electric Power in Russia

ONE of its greatest uses is the furtherance of transportation, since in many cases, even for long distances, a change from steam to electricity on railways will become a necessity. As reported by Consul General John H. Snodgrass, of Moscow, engineers estimate that the 24 large rivers of European Russia can furnish about 1,000,000 hp., while the resources of Siberia have not even been investigated.

The total possible power in Russia from hydraulic plants is estimated at some 12,000,000 hp. as compared with 34,000,000 hp. for Western Europe; but the development of power in Russia has been impeded by defects of the Russian law regulations for granting concessions for such developments, and the right of exploitation of water power as conferred on a private individual, puts him, under the provisions of the Russian law, in position to control the entire industry of the district, which the Government believes is not good policy. The waterways administration has, therefore, prepared a note in regard to the proposed changes in the law, which embodies the following points. These seem to be well formulated, and might properly serve as a basis for the action of our own Government in the policy with regard to future water power development.

(1) The right of disposing of the development of water power must belong only to the state, which may utilize it for requirements of common welfare or grant concessions to promote the development of industries.

(2) This right of exploitation can be given to private concerns only for a definite period on private property, and must be of temporary character, giving the possibility of revising the conditions and the purpose of the exploitation, from time to time.

(3) Any utilizing of water power for purposes connected with the interests of the state or public welfare must take precedence over all other means of exploitation of private character.

(4) Water power must be under constant control of the Government, which should take measures to prevent any abuse or injurious influence of a monopoly, and the rights granted, if abused at any time, may be withdrawn and taken over by the Government previous to the expiration of the term of the concession, suitable compensation being, of course, given.

"THE FIELD for American business development in Russia is unlimited," says W. V. Logan, of The Goodyear Tire & Rubber Co., who has just returned from the Czar's domains, writing on May 25. "All evidence is that Russia is having a great awakening, and there is no end to the possibilities there for American business institutions,—whose representatives study Russian conditions and prepare for business realizing that Russia is not the United States, and that American business methods must be modified and adapted when applied there.

"Take the automobile industry; when the war started, there were only 12,500 motor vehicles in Russia,—trucks, pleasure cars, large and small. The Government purchased between $15,000,000 and $20,000,000 worth while I was there. After the war, American automobile products will be very well known. The introduction is now being made. It is up to American manufacturers to follow the introduction if they care for the enormous business that can be theirs."

Mr. Logan sailed from New York in January. To reach Petrograd, he went first to London; to New Castle by rail; by 650-ton steamer to Bergen, Norway; thence to Christiana and Stockholm; from there, instead of across the Baltic he went to the North of Sweden, within 36 miles of the Arctic Circle, going around the North of the Baltic in reindeer sleighs; through Finland; then by train to Petrograd, the trip from London requiring 7 days. He remained in Petrograd 10 weeks, except for 2 short trips to Moscow.

"Moscow, the ancient capital, is Russia's business center. Petrograd is the governmental and diplomatic headquarters," says Logan. "Judging by those I encountered, the Russians are a most hospitable and courteous people. The official language seems to be French.

"In Russia it seems that people either have plenty of money or none at all. Those who have are great spenders. Food supplies are apparently plentiful; but city prices—hotel prices—are away up. I saw strawberries at 35 cents apiece; apples at 75 cents.

"I want to say just a word in tribute to Ambassador Marye, at Petrograd. Nothing can exceed the friendliness, the courtesy and untiring energy with which he and his staff are performing their difficult duties."

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Synchronous Motors

METHODS OF STARTING; CALCULATION OF SPEED; EXCITATION; HUNTING EFFECT; CONDENSER ACTION AN AID IN POWER FACTOR CORRECTION

WHEN operating 2 or more direct-current generators in parallel, the total load may be proportioned among the various units by the proper adjustment of the field rheostats of the respective machines, an increase of field resistance resulting in a decrease of load and a decrease of that resistance in an increase of load. With machines of the same capacity, the load is generally equally divided, while if machines of various ratings are employed, the load must be properly proportioned among the several machines in such a way that each carries its proper share.

Alternating-current generators operating in parallel cannot, however, have their loads adjusted in this manner. Proper division of load between these machines is controlled by their prime movers. This is sometimes accomplished by controlling all the engines from a common throttle valve, although the more usual scheme consists in running all the machines except one with their stop valves wide open and their governors fixed, so that the remaining engine may care for any variations in the common load.

Figure 1 is a conventional diagram representing 2 alternators connected for parallel operation. If, for some reason, the prime mover of machine B fails, not only will the load carried by this unit be thrown onto machine A, but machine B will become a motor and be driven by machine A, thus exemplifying an alternator driving a synchronous motor; hence, any machine usable as an alternating-current generator may be operated as a synchronous motor and vice versa.

STARTING OF SYNCHRONOUS MOTORS

ALL SINGLE-PHASE synchronous motors require some external means of starting, such as a small steam or other engine, or a small alternating-current induction, or direct-current motor. These starting units may either be belted or geared to the synchronous motor or, when a motor is used, this may be mounted directly on the shaft of the synchronous motor.

Polyphase motors can, however, very readily be started without any auxiliary starting motor. The application of the alternating current directly to the stationary armature without field excitation will result in a rotating magnetic field about the armature core. The eddy currents thereby produced in the pole piece will exert a torque on the armature and cause it to speed up to synchronism. Usually some form of starting compensator is employed for reducing the applied voltage during the starting period.

When up to speed, and its field normally excited, the motor is synchronized and connected to the supply lines in exactly the same manner that an alternating-current generator is synchronized and placed in parallel operation with one already running.

SPEED

SYNCHRONOUS MOTORS are practically constant speed machines. When overloaded, shunt-wound direct-current, and alternating-current induction motors will gradually slow down until stalled. Such is not the case with

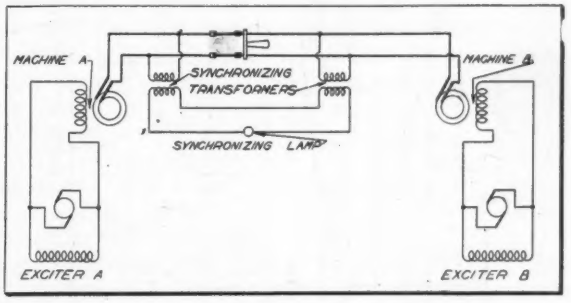


FIG. 1. TWO ALTERNATORS CONNECTED IN PARALLEL EITHER ONE OF WHICH MAY BE OPERATED AS A SYNCHRONOUS MOTOR

synchronous motors. The per cent of overload any such motor will carry is fixed for each individual machine and any increase of load above the specified maximum figure will cause the motor to "fall out of step," that is, out of phase relation with the supply voltage, and stop, after which the load must be disconnected and the motor again brought up to proper speed, synchronized and thrown onto the supply lines.

Synchronous motors are so called because they operate in synchronism with their driving generators, so that under all conditions of operation, the speed of such a motor bears a definite relation to the speed of the driving generator.

The speed of an alternating-current generator is a function of the number of poles and the frequency of the machine, so that, knowing the number of poles and the frequency, the required speed may readily be calculated. The current in any armature conductor passing from the center of a north pole to the center of an adjacent south pole will experience one reversal, or, in other words, will complete one cycle so that for each revolution of the armature the number of cycles will equal the number of pairs of poles and the number of

cycles per second will, therefore, be the product of the number of pairs of poles times the number of revolutions per second. Knowing the required frequency and the number of poles or pairs of poles of a given generator, the speed in revolutions per second at which this machine is to operate may be found by dividing the frequency in cycles per second by the number of pairs of poles.

Alternating-current generators and synchronous motors being interchangeable, the speed of the latter may, therefore, be calculated in the same manner as that of the former.

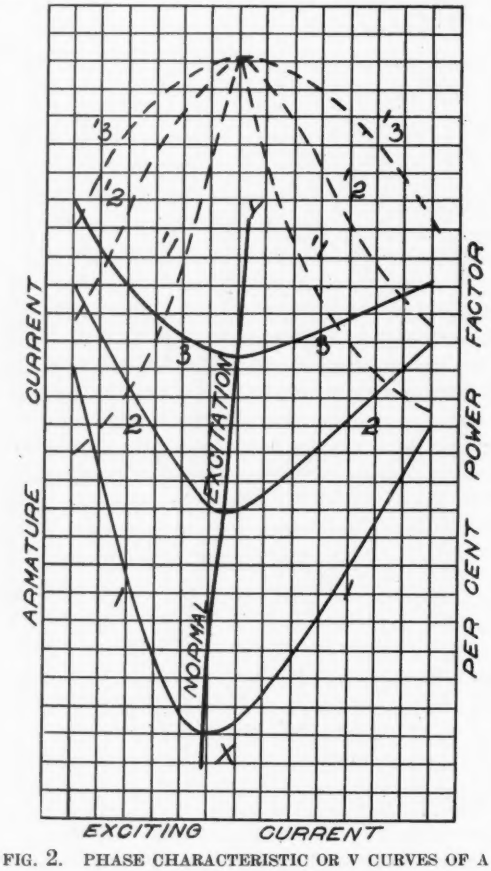


FIG. 2. PHASE CHARACTERISTIC OR V CURVES OF A SYNCHRONOUS MOTOR

Assume having a 24-pole generator used to supply 60-cycle service, and let it be required to determine the speed at which this machine must operate. From the above discussion, the speed in revolutions per second is equal to the frequency in cycles per second, divided by the number of pairs of poles, so that in this specific case the speed will be equal to 60 divided by 12, or 5 revolutions per second, or 300 r.p.m.

Let us further assume that this generator is driving a 12-pole, 60-cycle synchronous motor, the speed of which we desire to determine. This, in revolutions per second is, as above, equal to 60 divided by 6 = 10, or 600 r.p.m., so that with a ratio of 2 to 1 in the number of poles of generator and motor respectively, we have a ratio of 1 to 2 in their respective speeds. Or, in other words, we may say that the speed of any synchronous motor, as compared to the driving generator, is inversely proportional to the number of their poles.

Excitation

This, as in the case of alternators, may be supplied by a common exciter used in connection with a number of synchronous motors or alternators or may, as is usually done, be supplied by a separate machine the armature of which may be mounted on an extension of the motor shaft. Each machine requires, at no load, a definite exciting current under which conditions a minimum number of amperes will be drawn from the line. We find, however, by plotting the number of amperes of line current against the corresponding number of amperes of exciting current, that with any deviation from the normal exciting current an increase of line current will result. If various values of exciting current and corresponding values of line current readings be plotted against each other, a V shaped curve as shown at 1 in Fig. 2 and known as the phase characteristic will be obtained. Repeating this plotting of readings for half and full load, we get curves 2 and 3, Fig. 2.

From this it would appear as if an increase or decrease of field excitation from normal would result in a greater consumption of energy without any additional load on the motor. This, however, is not the case. If at the time of obtaining the phase characteristic readings, power factor readings had also been taken and plotted, we would have obtained curves such as shown by the dotted curves '1, '2 and '3 of Fig. 2, thus indicating that even though the line current becomes excessive, the actual energy consumption is but little more at extremes of excitation than at normal excitation. At high values of line current, the power factor is necessarily extremely low.

Another interesting point which the use of a power factor meter will bring to light is that, with an exciting current below normal, the line current lags behind the electromotive force, while with an exciting current greater than normal the line current will lead the electromotive force. As will be shown in the following paragraph, it is this property of the synchronous motor which gives it an advantage over other types of alternating-current machines.

Power Factor Correction

To secure the greatest economy both in the first cost and operation of alternating-current machinery, transmission and distribution lines and so forth, it is imperative that the power factor of the system be as near unity as possible. This, however, is a condition not easily obtained, as the greater share of the load carried by the average station is of an inductive nature, such as transformers and induction motors, resulting in a low lagging power factor.

As stated above, the current taken by a synchronous motor will lead the electromotive force when the exciting current of the motor is greater than normal or, as technically stated, "an over excited synchronous motor will draw a leading current," thus enabling it to neutralize wholly or in part the lagging effect of an inductive load.

Hunting

One of the greatest difficulties encountered in the operation of synchronous motors, especially if these be supplied with current generated by machines driven by

reciprocating engines, is the tendency to "hunt," resulting in a considerable voltage disturbance over the entire system.

When the load on a synchronous motor is suddenly increased, the motor slows down, momentarily, and falls behind the generator in phase; and when it has fallen behind sufficiently to take in enough power to enable it to carry its load it is still running somewhat below synchronism. It, therefore, falls still further behind and takes an excess of power from the supply lines, which quickly speeds it above synchronism. It then gains on the generator in phase until it takes in less power than it requires for its load when it again slows down, and so on. This oscillation of speed above and below synchronism is called "hunting" and is accompanied by great change in the current drawn by the motor and by a rapid rise and fall of the electromotive force between the motor terminals.

Hunting is often produced by the periodic change in the speed of the engine driving the generator. Thus the engine momentarily increases in speed as the steam acts upon its piston and diminishes its speed during the intervals between strokes. This, however, may be eliminated by the use of turbine driven generators.

Hunting may be entirely eliminated, or at least greatly reduced by the use of a loose flywheel on the motor shaft or by the employment of "dampers," which consist of rectangular copper frames driven into place under the overhanging tips of 2 adjacent poles. Such a damper is provided between each pair of adjacent poles, all around the field, both in the alternator and in the synchronous motor.

Another form of damper found quite effective is the squirrel-cage damper. Heavy bars of copper are placed in slots at the surface of the poles and their ends bolted to 2 closed copper rings, so as to short-circuit all the bars.

The principle of the damping action is that the shifting magnetic field sets up an induced current in the short-circuited frames or bars of the dampers and these currents react on the magnetic field so as to oppose the shifting of the flux and thereby dampen the hunting oscillations. The electrical effect of the dampers is analogous to the mechanical effect produced by immersing the bob of a swinging pendulum in a heavy oil, which resists the motion of the bob.

Use of Synchronous Motors

Synchronous motors are applicable only where no high starting torque is necessary, where frequent starting and stopping is not required, and where constant speed is desired. Their field of usefulness is, therefore, somewhat limited. Due to the effect which a variation of its field excitation has upon its power factor, the synchronous motor is extensively used for the purpose of correcting a low, lagging power factor, such as is caused by heavy transformer and induction motor loads. Many central stations supplying both alternating and direct current generate the former only, and obtain their supply of direct current either from direct-current generators diven by synchonous motors, or from synchronous converters. Under proper conditions of operation, the field excitation of these synchronous machines is maintained at its normal value, but with a heavy inductive load on the system, creating a low, lagging power factor, overexciting the fields of the synchronous machines, will cause the motor to draw a leading current, and thereby improve the power factor.

When there is no use for the mechanical power in the central station, synchronous motors are many times connected to the distribution system at some distant point and allowed to float on the line with an overexcited field, for the express purpose of correcting a poor power factor. And in order to prevent the idle operation of such machines, the managements of central stations many times offer special inducements in the form of lower rates to power consumers who will use synchronous motors instead of induction motors.

When used for the express purpose of power factor correction, synchronous motors are generally termed synchronous condensers.

Balancing Action

The fact that a synchronous motor draws a leading current when overexcited and that the value of this leading current is increased with an increase of overexcitation, gives to this type of polyphase machine the capability of restoring a balance to an unbalanced polyphase circuit. When a slightly overexcited motor is connected to the terminals of a balanced or an unbalanced polyphase system, all phases of the motor armature draw a leading current. That phase winding, however, which is connected across the terminals of lower voltage, draws a greater leading current than the other windings, because its overexcitation is relatively higher, hence the compounding tendency of the leading current is more marked in this phase than in the others, and the voltage thereof is increased. This action tends to balance the circuit, not only in voltage but in current as well, because combinations of leading and lagging currents give reduced resultant currents.

Advantages and Disadvantages

The synchronous motor, especially in large units, possesses a number of features which make its use at times preferable to that of the induction motor. These may be briefly summed up as follows: (a) Unvarying speed at all loads; (b) Power factor, variable at will by change of exciting current, can be made approximately unity at any load; (c) The current in the armature can be made to lead the electromotive force by overexciting the field magnets, thus producing the same effect as a large condenser. The leading current in the armature can be used to neutralize the unfavorable effects of inductance in other parts of the system; (d) The synchronous motor is cheaper to build, especially for low speeds, than the induction motor; (e) Its efficiency is generally higher than that of the induction motor; (f) It is specially adapted to high voltage winding.

This type of motor has, on the other hand, the following disadvantages: (a) It is not adapted to work requiring variable speed; (b) It has small starting torque, hence is not suitable for work where the load at starting is large, or frequent starting is required; (c) It has a tendency to "hunt"; (d) It requires an exciting current which must be supplied by an outside source; (e) It requires skillful and intelligent attention.

Practical Experience in the Operation of Electrical Machinery

GENERATORS MOTORING AT NO-LOAD

BY E. C. PARHAM

FIGURE 1 illustrates the connections for operating 2 compound-wound generators in parallel by means of an equalizer. In connection with this diagram will be considered an operator's complaint that one of the 2 machines would always "motor" the other one when the external load became zero, either as the result of there being cars in service using no current or because of the station circuit breaker opening.

Assuming that the correct no-load adjustments have been made, the currents of the 2 machines combine to flow through the external circuit, represented by the broken line, as long as this path remains intact. The function of the equalizer connection, which places the series field windings of the machines in parallel, is to minimize the motoring tendencies incident to the ma-

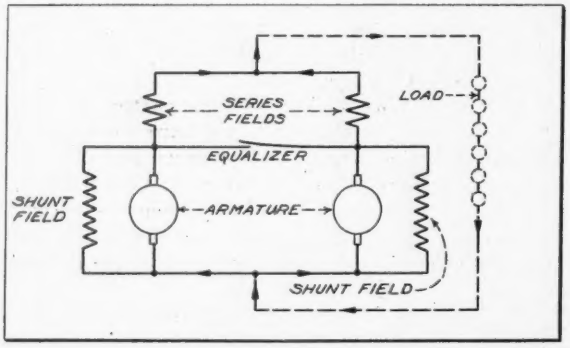


FIG. 1. CONNECTIONS FOR OPERATING 2 COMPOUND-WOUND MACHINES IN PARALLEL

chines having unequal voltages. It does this by strengthening the field of the lower voltage machine, thereby increasing its voltage and causing it to take more load as a generator.

When the external circuit is open and the equalizer open, but the local circuit around the 2 machines closed, any difference between the voltage of the 2 machines will result in the higher voltage machine backing current through the lower voltage machine. As this current must pass through the series field of the lower voltage machine in the reverse direction, it opposes the field due to the shunt winding and further decreases the generated e.m.f., which at this time is really the counter e.m.f. of a differentially connected motor. The motoring current therefore further increases and this increase weakens the field more, thereby still further decreasing the counter e.m.f. The net result of these interactions is that the lower voltage machine quickly assumes the characteristics of a short-circuit across the higher voltage one. Unless circuit-breakers relieve the situation promptly, the motored machine is likely to have its rotation reversed; this will occur if the series winding is strong enough to overcome the shunt field and thus reverse the polarity of the resultant field, because the machine will then operate as a series motor (which turns in the opposite direction from what a series generator would for given connections).

With the external circuit open and the equalizer circuit closed (the condition under which the operator claimed one machine would motor the other) the series fields of both machines are out of action, the equalizer short-circuiting them and at the same time serving as a conductor for completing the local circuit between the 2 armatures running in the fields excited by their respective shunt windings. The 2 machines when under this condition may be considered as shunt generators connected together with voltages opposed. So long as the opposing voltages are equal, no current will flow between the armatures; but if for any reason one of the voltages becomes a little higher than the other, the lower voltage machine will be motored, although it will continue to run in the same direction because shunt generators and shunt motors operate in the same direction for given connections. The extent to which one machine will motor the other depends upon the amount of the difference between their voltages. Slight differences may be due to speed variations, to unequal heating of

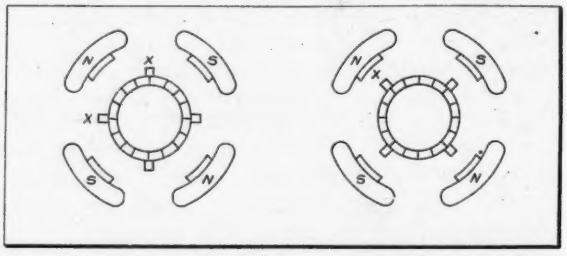


FIG. 2. BRUSH HOLDERS PLACED BETWEEN POLE PIECES

FIG. 3. BRUSH HOLDERS LOCATED OPPOSITE CENTER OF COILS

shunt fields, or to different armature reactions incident to unlike brush shifts. To whatever cause the motoring may be due, the motored machine is apt to spark because its brushes are located for generation and not for motor operation.

Assuming the generators to be practically similar in all respects, but that their brush shifts are unequal, the armature reaction of one machine will affect the magnetism of its pole-pieces more than will the armature reaction of the other machine affect *its* pole-pieces. Although each machine may have first been carefully adjusted to give the correct no-load voltage, the result after the 2 have been loaded and the load removed (either by the main circuit-breaker operating or by the external load decreasing to zero) may be that the no-load voltages of the 2 machines will be found to be different in amount because the residual magnetism of one generator may be much greater than that of the other.

This was the trouble in the case under consideration. The flashing and motoring at no-load was eliminated by giving the brushes of both machines the same number of bars forward shift. It was then necessary to readjust the compounding of one of the machines by changing the length of its series field shunt.

Changing Motor Mounting

Some motors are constructed to permit of floor, wall, or ceiling mounting. In the absence of instructions to the contrary, it is customary to ship the motors arranged for floor mounting.

To adapt them for wall mounting the end shields are rotated 90 deg., and for ceiling mounting 180 deg., in order to bring the oiling devices into their normal position. As a rule, the shifting of the end shields shifts the brush-holders to a position which, according to the number of poles, might reverse the direction of rotation or render operation impracticable on account of sparking. One method of checking brush position is first to arbitrarily mark alternate field coils N and S, as shown in Figs. 2 and 3. If the holders are located midway between coils, Fig. 2, 2 holders that include an N coil, for example, are marked. After shifting the shield, the brush-yoke is shifted until the 2 marked holders again include a field coil marked N if the direction of rotation is to remain unchanged. Where each holder is located opposite the center of a coil, Fig. 3, a holder opposite a marked coil N, for example, is marked and after shifting the shield the marked holder should be placed opposite a field coil marked N, if the same direction of rotation is desired.

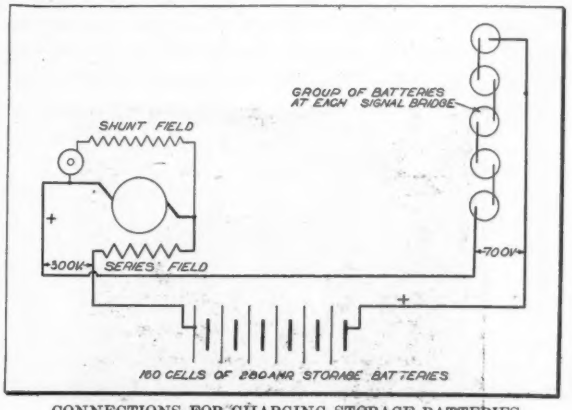
These instructions expressed in terms of angles would read as follows: After laying the motor upon the floor in the position in which it is later to be mounted on the wall or the ceiling, as the case may be, and rotating the shields to correct the position of the oilers, the rocker arm or yoke should be turned backward through the same angle that the shield has been turned forward. The brushes will then be in the correct position for sparkless operation and for the original direction of rotation. Such a double shift is equivalent to loosening the yoke and holding it stationary while rotating the end shield. As far as sparkless operation in the original direction is concerned, it is immaterial whether the marked brush-holder be moved to its original position relative to the marked field coil or whether it be moved to the same position relative to another field coil of the same mark; in the latter case, however, it may be necessary to lengthen some of the leads.

Failure to observe the requirements of relative brush-position has caused much trouble and delay to operators who have had occasion to shift a motor from one mount to another or who have changed their minds after specifying that a motor should be shipped for a certain mount. —General Electric Review.

Charging Signal Service Batteries in An Emergency

Some time ago, the plant we used for charging signal batteries, 25 miles from Pittsburgh, went out of commission. This plant was composed of 2 500-volt d.c. generators used for charging batteries which operate signal bridges. These batteries are charged in groups as shown in the sketch, each group consisting of 50 cells averaging about 110 volts per group. These 2 generators burned up, both in one day, and signal batteries were discharged.

Having no other power at this point, we had to arrange to get them charged otherwise. Having a 250-volt d.c. generator at Pittsburgh and several sets of storage batteries such as are used for car lighting, we connected them up as illustrated, raising our machine voltage to 300 volts and inserting 160 cells or 80 trays in series with our machine. By doing this, we had a line voltage of 700 volts at Pittsburgh, sufficient to charge these batteries, which are scattered over a distance of 25 miles.



CONNECTIONS FOR CHARGING STORAGE BATTERIES

The signal batteries were charged from 1 p. m. until 10 p. m., after which it was necessary to charge the car lighting batteries for the next day; this was done from 10 p. m. until 6 a. m., by cutting this group of batteries in half and connecting directly across the line. This system was in service about 3 weeks, giving us no trouble.

J. L. Armstrong.

"Home Electrical" Exhibit

At the Panama-Pacific Exposition, an exhibit which has attracted unusual attention, is found in the Palace of Manufacturers, and represents a full sized home of bungalow design and moderate cost, fully equipped with electrical apparatus to perform domestic

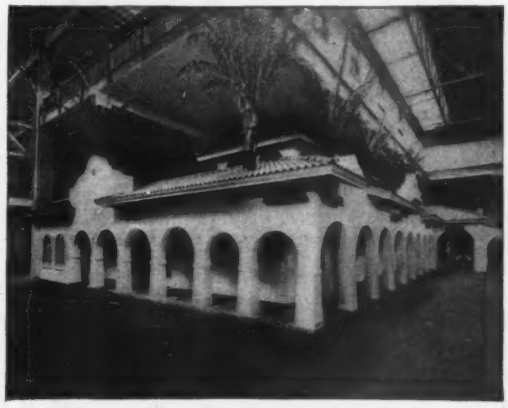


FIG. 1. HOME ELECTRICAL OF THE GENERAL ELECTRIC COMPANY EXHIBIT AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

tasks. Electricity is used for cooking, washing, laundering, sweeping and dusting, as well as heating, lighting and cooling the house. This is one of the exhibits of the General Electric Co., but is co-operative, since many

of the devices installed are furnished by other manufacturers. The exhibit is in complete operation and illustrates simply the practical modern home without any radical innovations.

The building has 6 rooms, with the addition of bath, refrigerator room and laundry, and a connected garage, having workshop and a small creamery as might be needed on a farm. Mazda lamps are used for lighting, and the house number is shown as an electric transparency. An electric fireplace furnishes both warmth and light in the living room, which has semi-indirect lighting fixtures. Heating by electricity and ventilation by an electric fan provide comfort in the dining room, also there are electric cooking devices for the preparation of lunches and light refreshments and for such table convenience as is usually desired. Electrical devices for dish-washing, for light cooking, for polishing, and the usual electric bells and annunciators complete the dining room service.

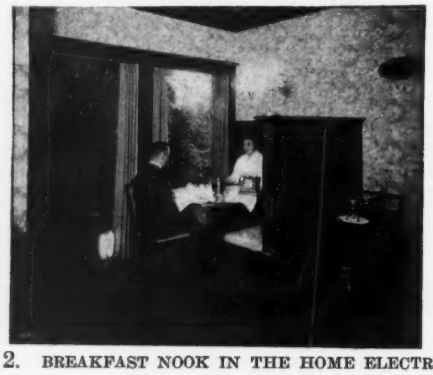


FIG. 2. BREAKFAST NOOK IN THE HOME ELECTRICAL

FIG. 3. KITCHEN IN THE HOME ELECTRICAL

The kitchen, of course, has an electric range, with hot plates, broiler and ovens, and an electric water heater. Also, an electrically lighted and cooled refrigerator is provided, which can be used not only for the preservation of food, but also for the freezing of small cubes of ice.

The bedroom exhibits electrical toilet conveniences, including vibrator, hair drier, and the more common devices. In every room is connection for the vacuum cleaner, which is used throughout the building. An interesting provision in the bedroom is the burglar switch, which lights every lamp in the house.

Electric heating and electric toys in the nursery, and toilet conveniences in the bathroom, including the vibrator, hot water cup and electric radiator, and the hot water heater for the bath are, also, in evidence.

Other devices about the house are the electrically driven sewing machine, electric irons for pressing, and the intercommunicating house telephone.

In the laundry are found the washing machine and mangle, various weight irons for ironing and pressing, and a hot plate for clothes boiling.

Water for the entire house is furnished by an air pressure system, driven by a small electric motor, which is started and stopped by a pressure switch.

In the garage is found, of course, the electric coupe, with mercury arc rectifier for charging, and a small vibrator for charging the lighting batteries. An air heater is also provided, and an electric tire pump. In the adjoining workshop are found a generous provision of tools, electrically driven, and such auxiliaries as soldering irons, glue pot and other shop conveniences.

The illustrations herewith show parts of the exhibit.

Strongest Part of Belt

By N. G. Near

THE notion seems to be prevalent that the flesh side of the belt is the weaker, but such is not the case. An experiment was made in which a belt was split exactly through the middle, hair side becoming one piece and flesh side the other. These pieces were then tested carefully in tension, and the flesh side was found to be stronger, the hair side having only 72 per cent of the strength of the flesh side.

It is, therefore, evident that in the manufacture of belts, as much of the flesh side should be left in place as possible; it should not be shaved off.

U. S. C. Service Commission announces an examination for illuminating engineer, on July 7 and 8, 1915, to fill vacancies as they may occur in this position at $1200 a year, in the office of the Supervising Architect, Treasury Dept., Washington, D. C., and in positions requiring similar qualifications. This examination supersedes the examination for electrical engineer and draftsman, which was scheduled to be held on June 23 and 24, the announcement of which (No. 461) has been canceled. The following subjects will have the relative weights indicated: Theoretical and practical questions in electrical science (covering the subject with special reference to lighting and elevator work in public buildings), 25; drawing and design (involving ability to design and draw plans, etc., for all apparatus and machinery connected with electrical work in public buildings), 40; training and experience, 35. Applicants must have the equivalent of a high-school education and not less than 3 yr. special experience as a draftsman principally in connection with electrical work and illuminating engineering, or be technical graduates with not less than 6 mo. experience as electrical draftsman or in the installation of electrical wiring or apparatus. Age, 22 yr. or over on the date of the examination. Applicants must submit to the examiner their photographs, taken within 2 yr. Apply for Form 1312, stating the title, Illuminating Engineer (Male), to the U. S. Civil Service Commission, Washington, D. C.

Bleeder Turbines*

FEATURES OF OPERATION AND ECONOMY. BY F. W. LAAS.

BECAUSE of the large volume of steam for the heating system, bleeder installations should have large valves, strainers, piping, etc., and provision for removing foreign matter, which may be more readily brought over from the boiler under these conditions, should be made. There is, also a slight tendency to unbalanced pressure on the dummy rings and thrust bearings.

Regulation is not quite as good with the bleeder type turbine as with the straight condensing type, but the difference is slight. Because of the volume of steam taken in the bleeding, the governing devices should have a wider range of action, in order to carry heavy electrical loads when the maximum amount of bleeding is being taken.

Back pressure valves must be tested often, to guard against back feeding from the heating mains into the low-pressure stages, in case the load is lost on the turbine, or excitation fails, as such back feeding would result in over-speeding.

All parts of the bleeding system, such as valves, stuffing boxes and piping, must be absolutely tight, in order to get good results when running the turbine noncondensing.

Advantages of the bleeder system are, that a sudden peak load, or an accident to the boiler equipment, calling for all the steam capacity of the plant to be used in the turbine, can be taken care of by cutting out the heating system for a short time and using all steam available with the turbine run condensing. Also, no oil is taken into the heating system, which reduces the upkeep on meters, traps and air valves, and does away with odor.

In practice, it is found that there is no difference between a steady and a pulsating supply of steam to the heating system, and the bleeder system, with proper connections, has the advantage that a shortage of auxiliary steam for heating the feed water can be made up by bleeding from the turbine, or an excess of steam from the auxiliaries can be fed back into the low-pressure stages, thus avoiding waste of steam. In one instance, the steam from 50 hp. of condenser auxiliaries, put back into the low-pressure stages of the main unit, gave 80 hp. additional supplied by that unit, the steam being about 2000 lb. an hour. For a 1500-kw. bleeder unit, when using 24,000 lb. of steam an hour, at 5 lb. gage, through the bleeder system, a saving of 9500 lb. of steam an hour was effected over using the turbine straight condensing and supplying steam direct from the boiler to the heating system. There is some reduction in capacity of the turbine unit by using it in bleeder form. A 3500-kw. turbine, bleeding steam at 16 lb. back pressure, to supply 400,000 sq. ft. of radiation, and 40,000 ft. of radiation in the mains, gave a maximum of 3000 kw.; while running condensing, without bleeding, it would give a maximum of 4500 kw.

In case of a turbine arranged to bleed out, or bleed in steam, if the heating demand is such that no steam passes through the low-pressure stages, there is a possibility of overheating the blades in these stages, or if bleeding in, the supply of steam in the lower stages is sufficient to carry all the load, and no steam passes through the high-pressure stages, overheating of blades may occur in the high-pressure end. This is, of course, an unusual condition and seldom likely to occur.

In choosing the unit for a bleeder system, special care must be taken to select the proper size and range for both electrical and heating conditions, used separately and together, and for adequate speed control, and generally speaking, the electrical load should overbalance the heating load, which calls for attention, both in choosing the unit and arranging the loading.

In the discussion on this paper, mention was made of 2 7500-kw. turbines of bleeder type at Rochester, N. Y., in which it was found best to increase the nozzles in the first stage 25 per cent, to take care of the increased amount of steam passing through them. The bleeder connection was from the first stage with reducing valve to the heating system, and with means provided to prevent feeding from one turbine to the other, with change of load division. No steam was taken through the bleeder with load under 2000 kw., and above that load it was self regulating. These units take the excess of load over that which is carried by a hydraulic station and by a fixed amount of power from the Niagara transmission system, hence the load varies greatly and the test on regulation is severe.

In apportioning the expense of the station between the heating system and the electrical load, the total steam from the boilers is metered, also the steam pressure to the heating system and the coal costs, labor costs and incidentals for the boiler room are apportioned between heating load and electrical load, according to the steam supplied for the 2 purposes. It is felt that credit should, also, be given to the heating system for the better load factor maintained on the boilers, due to this heating system, over what they would have if the lighting load alone were carried. This point has not been clearly worked out. The fixed charge on the heating system is that due to the extra investment required in order to carry the heating load. The station is fortunate in having a street railway load which has a morning peak corresponding to the morning heating load peak, so that, at this time, the 2 loads increase together.

Tests of the turbines show little change of economy with change of back pressure, the steam consumption per kilowatt-hour with 12 lb. back pressure being 35 lb., and with 5 lb. back pressure, 30 lb., but this is due, in part, to the fact that the turbines were designed to take care of the variation in expansion due to this change in back pressure.

When bleeding the turbines out or in at 5 to 15 lb. gage pressure, with many auxiliaries exhausting into an auxiliary main, the steam used in the heater so far as

*Abstract of paper and discussion before the N. D. H. A. convention.

needed and the balance returned to the low-pressure stage of the turbine, regulation is carried within 2 per cent.

On a hot water system in another plant, the bleeder turbine is arranged to heat the water, which is passed through a surface condenser supplying 100,000 sq. ft. of radiation. The steam can be bled from the first stage to increase the temperature of the water, if necessary. With cooling water leaving the condenser at a temperature of from 130 to 145 deg., the vacuum is maintained at from 25 to 22 in., with full heating load. When the heating load is light, the vacuum will run down to 26 in.

The pump, which circulates water through the heating system, is bypassed so that if all the water is not needed in the heating system, the surplus can be returned to the inlet of the condenser.

Foreign Development in the Power Plant Field

STEEL AND IRON WIRE FOR ELECTRICAL PURPOSES; RUSTING OF IRON AND STEEL. BY J. H. BLAKEY.

THE metals usually employed as electrical conductors, for the winding of machines, for cables and distribution wires, are copper and its alloys, bronze or brass; in addition to these aluminum has come to be employed to a certain extent, as a conductor, for wires and cables. At the present time, Germany is without copper, which is imported principally from the United States and England; and it is almost without aluminum, which is in great demand for the construction of Zeppelins, because the bauxite used in its manufacture comes almost entirely from the south of France. Consequently they are considering the possibility of using iron or steel in place of copper or aluminum, at least for transmission lines. The Association of German Electricians has recently published in the Electrotech. Zeits., a paper giving useful data with reference to the electrical properties of the different metals. The figures in the following table give relative values; they are the result of the metrical measurements used in the laboratory of the Association:

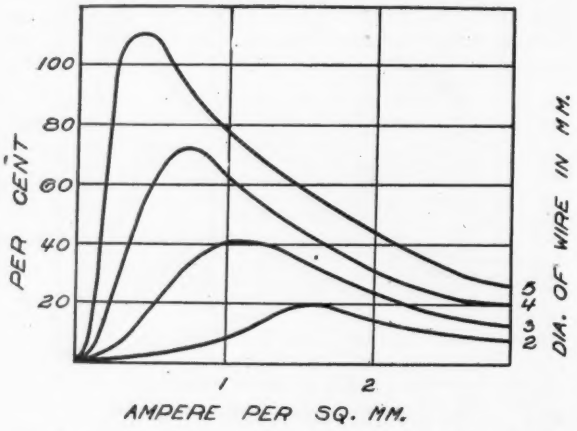


FIG. 1. INCREASE OF RESISTANCE OF IRON WIRES WITH ALTERNATING CURRENT

	Copper	Aluminum	Iron	Steel
Density	8.9	2.77	7.8	7.9
Resistivity	1.59	3.0	14.0	16.0
Conductivity	100	57	12	11
Wires of 1mm. dia.—				
Resistance	20.3	35	175	200
Weight, kilog. per kilo.	7.0	2.3	6.0	6.0
Weight, lb. per mile	24.64	8.1	21.12	21.12

With the continuous current the working conditions for wires of iron or steel are simple enough; for the alternating current, the effects of induction and impedance complicate the phenomena. The increase of resistance due to superficial effect is indicated in Fig. 1 for iron wires of from 2 to 5 mm. in diameter, in function of the density of the current and for a frequency of 50 periods. Figure 2 is also a resistance diagram, and shows the result with the continuous current (full lines)

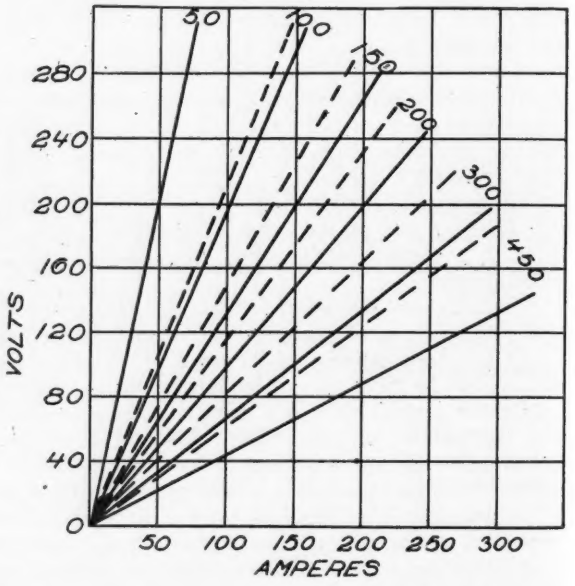


FIG. 2. LOSS OF VOLTAGE PER KILOMETER (0.621,37 MI.) IN STEEL CABLES. NUMBERS ON DIAGRAM INDICATE SECTIONAL AREA OF CABLE IN SQ. MM. (0.001,55 SQ. IN.)

and with the alternating current (dotted lines) on steel cables of different section. Fall of tension is indicated in volts per kilometer, in function of the intensity of the current. All wires of iron or steel which are not otherwise covered are either tinned or galvanized.

PROTECTION OF IRON AGAINST RUST

IN SCHWEIZ. BAUZEITUNG, M. Zschocke describes experiments recently made by himself and others on the rusting of iron and steel. As a result of these experiments, he recommends the use of a coating of animal or vegetable grease in which has been emulsionized some salt of chromium. Good results were also obtained by making an emulsion of grease and whitewash. Specimens of cast and wrought iron and steel coated in this way and watered daily were found to be free from rust after several months.

Jeremiah Judson, C. E.

THE WEAK POINTS OF BLUFFING; JERRY PUTS ONE ACROSS ON THE FOURFLUSHER

AFTER the little game of poker in the 94-in. cylinder of the big pump, there was a lull in the story telling for several weeks as Jerry had been the victim of a little mishap for which no one seemed to be to blame and for which Jerry was the official goat.

In the course of a few weeks, however, he had so far recovered as to be out without his face plastered up like the man in the cartoons, and naturally he went out to the shop to see how things were getting on.

Again it was noon, and the war bread, bologna, garlick, doughnuts, and angel's food had been put where it would do the most good. Then the boys gathered around Jerry to congratulate him on his escape and rapid recovery, as he sat on a keg padded with waste, while they arranged themselves for the story—but it didn't come.

"Jerry, when you told us that last story about the fourflusher, you implied that there was another coming; there was, wasn't there?" spoke up one of the boys.

"Yes, and I am glad you mentioned it. You see, the fourflusher had what was called a 'bold front.' This is like a coat of paint on the prow of a rotten tramp steamer: it looks nice, but it doesn't stand up when rough weather approaches.

"He came back to the shop for a few days, or as he said, 'to recover his health.' The boys all said that it was to recover his nerve, for he ate the boarding house into bankruptcy, and took lots of 'tonic.' He had not lost any of his cunning in overawing all the high guys.

"Finally he got an engine to erect at a place in New York. I do not recall what plant it was; it doesn't make any difference. But he went over there and began operations. It seems that the purchaser was to 'furnish all labor, material, tools and supplies necessary properly to erect the engine and place it in successful operation.' You boys know how those contracts are worded.

"They brought around a lot of rope, chains, pulley blocks, tackles, etc., and he went at it. He refused to let any of those ex-sailors make a hitch and did all of it himself, although he could not tie a square knot without thinking over it. The engine was about 4000 i.hp., or along there, and the frame was some chunk, especially as it was a tandem. Well, the fourflusher tried to show how he could slap things together when he had a crane, so he got the crane over about where he thought the center of gravity was and began to wind the 2-in. rope around the frame. He gave the crane man the once over; but that individual, though not an erecting engineer, knew when it was time to put bagging between the rope and the sharp corners of a casting. He hollered and wiggled his hands and motioned; the fourflusher insisted that all was well, and that the next move was up to the crane man. He also used expressive language to convey his thoughts, so the crane man did as he was told and up she went.

"He carefully edged down the track toward the engine foundation with the frame high in the air to clear the engines that were running. When almost over the foundation someone hollered, 'Look out!' and with a sharp crack, the rope parted at the corner of the frame and down she came, turning a little so that when it struck, it landed on its side.

"When the smoke cleared away, the main bearing was down cellar on one side, and the guide barrel, on the other, broken beyond redemption. Luckily, there was no piping in the way, as this was a new addition to the plant. Then the fourflusher sent a wireless up to the crane man and the latter called the former a few things also, and asked him where he learned to make a hitch on a rough casting without putting bagging under the rope. The fourflusher insisted that someone had *put acid on the rope,* and even went so far as to say that the man that did it didn't work on the floor. The crane man took this as a personal matter and came down, and but for the restraining hands present, there might have been a little marquis of gooseberry stuff.

"Well, he wrote to the firm and made the same bluff and it stuck, partly for the reason that some acid in their own store room had recently leaked out and into a coil of rope that was used for slings, etc.

"There was only one thing to do, and that was to furnish a new frame; but I never heard how the case was settled between the firm and the purchaser. Things like that are what might be called 'diplomatic secrets.'

"Finally, the engine was set up, with several other little things thrown in for spice; but as the purchaser was not ready to start up then, the fourflusher went to pastures new. I happened to be over in Pittsburgh when I was sent up to start up the engine in York State, and then the whole thing came out in the wash. I got the whole story, not once but several times, as there were any number of men around there who had it in for the fourflusher for something or other. Even the manager unbent enough to say a few things that I hope he didn't say about me. But the engine went off all right.

"When I went back to the shop of course I was up on the carpet and the firm tried to get a few of the facts of the case from me. While I admitted that I had heard a *few* things, I had lost the reproducing needle of my phonograph. If the firm wanted to know about the case, they had the privilege of writing to the purchaser as to what we both did when on the job; but I told them they would not like it if I were to say a few little things about them under similar conditions—and they saw the point.

"Next he went to a place over in Pennsylvania to set up 3 big cross compounds. These engines were so large on the low-pressure side that the wristplates were functioned from below the wristplate stand, thus putting the eccentrics on the opposite side of the shaft. The high-pressure side was all right as here the wristplates were functioned from the top, making the motion direct. He had a little trouble with the erecting; but I will skip

that, as he generally had more trouble than he really was entitled to. Finally, the day of starting up came, and he warmed up and cut loose. The engine ran all right till the low-pressure cylinder got warmed up and then it began to run in opposition to the high and finally everything was full of steam at boiler pressure and there he was, 'stuck on the middle,' and could not move either way.

"When I came back to the hotel in Boston, one night, I found a telegram to go over and help this man out of his trouble. In due time, I arrived and he was studying the valve gear diagram and saying things. He swore that the design was wrong and lost no time in saying that he had written the firm to that effect.

"We walked over to the engine and as soon as I saw where the low-pressure eccentrics were, I tumbled right away, and began to study ways and means to make the change without putting him next, for the time being. Was this port opening all right? Sure, just as the drawing called for. Exhaust lap O.K.? Sure Mike. Did he have the indicator on? No, the—— thing wouldn't run long enough to take a card. Was the wrist-plate travel all right, and did the carrier arms wobble as good carrier arms should when brought up properly? Most assuredly, Michael. Did he allow for expansion of eccentric and drop rods?

"That stumped him. He didn't know what I meant. You know that on a big engine, the eccentric and drop rods, being practically cold, retain their normal temperature, while the cylinder and adjacent parts get hot and expand, thus throwing these rods out just a fraction of an inch. It doesn't amount to much, except as a catch question for some of these state examiners, except that if the drop rods are too short, when the cylinder warms up and expands (upward of course), the rods will naturally hold the drop levers down so that they cannot engage—that is, if the dashpots work briskly. All this didn't amount to a pinch of snuff so far as the trouble was concerned, but it gave me the opportunity to fix things and not let on how it was done, and make him look foolish till I felt like telling him.

"So we took off the back bonnets on the low and went over the setting. It was all right; that is, fairly good, as good as most and better than all of them after you put the indicator on and set things according to demand and not by the blueprint. Then I loosened the eccentrics and rolled them around the shaft to see if the wrist-plate travel was all right. It was. Then we barred the wheel over onto one of the centers, and I set the eccentrics again—this time on the right side of the shaft. Putting on the back bonnets again, I told him to start up till I saw it perform.

"Well, sir, that engine went right along about its business as nice as you please and you could have knocked that man over with a strong breath of garlic. He could not see what we had done that could affect it, and didn't see the only thing that was done, although he helped me to do the work.

"Well, boys, there goes your whistle again. I am going over to the drug store for some tobies. Did I tell him? Sure I did, about a month afterward. Maybe I'll be in to work in a week if I feel all right." And Jerry Judson went out as the wheels began to hum in the big shop.

Safety in Refrigerating Plants

REQUIRED PRECAUTIONS IN DESIGN, INSTALLATION AND OPERATION

THE ever-increasing congestion in our large cities is one of the most potent of the causes of the rapid development of the artificial ice and refrigeration industry. If a hotel manager a generation ago had been asked to serve fresh vegetables in midwinter, he would have had considerable difficulty in complying with the request; but fresh vegetables are available today, at practically all seasons of the year, and at a cost within the means of persons in moderate circumstances. This is only one of the many items that have made the refrigerating industry possible, and because of this industry many things that were luxuries a few years ago are now considered to be necessities. Perishable food must be preserved in a suitable condition to provide the necessities of subsistence for the public, and especially for that part of the public that lives in the congested sections of our cities. These persons have neither space nor facilities for preserving large quantities of food stuffs, and must therefore depend on the dealers, both wholesale and retail, for their daily supplies. Under this arrangement the dealers must keep a comparatively large stock constantly at hand, and in order to guard against loss they must have refrigerating plants of their own, or must depend on natural or artificial ice, to maintain their establishments at proper temperatures.

There are in the United States over 12,500 ice-making plants, having an aggregate annual output of about 20,000,000 tons. This does not include the thousands of private refrigerating plants in small restaurants, meat markets, grocery stores, and private dwellings. The principles of artificial refrigeration are being applied in more than 150 different industries, including among others mining, paper making, woolen and silk manufacturing, laundering, and tobacco manufacturing.

As might be expected, an industry in which chemicals and highly-compressed gases are used in connection with tanks, piping, and moving machinery, is not immune from accidents. The growth of the refrigerating industry, employing high-pressure gases with the attendant risk of explosions and other accidents, is attracting the attention of municipal authorities to such an extent that regulations for installing and operating the plants have been drawn up and put into effect in many localities. No doubt these regulations will have to be revised as experience is gained in their application, and in this respect they may be expected to have a history similar to that of analogous regulations applying to steam boilers.

The fact that municipal authorities are taking steps of this kind in connection with the refrigerating industry indicates a growing public appreciation of the impor-

tance of the hazards pertaining to it. As in almost every other industry, the majority of the accidents that occur are avoidable, provided sound engineering principles are followed in the design, installation, and operation of the plants. It follows, then, that the engineer who designs the plant, and the man who supervises the installation, should bear in mind the question of safety; and it is equally important to place competent men in charge of the operation of the plants, because the judgment and ability of the men who supervise the work are exceedingly important factors in preventing accidents.

Leaks in a refrigerating plant usually occur at the gaskets, or through cracks in pipes or other defective parts of the apparatus under pressure. Often such leaks have no other consequence than the loss of a certain amount of ammonia; but when the defect is of such a nature as to allow large quantities of ammonia fumes to escape, more serious results often follow. For example, if there are arc lamps or open flames in the room, or a free connection between it and the boiler room, the mixture of ammonia, hydrogen, and oil-vapor and other volatile impurities may ignite and fill the whole compartment with flame for a short time, with serious consequences to anyone present. The fire hazard from this cause may be practically eliminated by using electric incandescent lamps, and installing self-closing doors between the boiler room and the rooms where leaks are likely to occur.

A leak of sufficient size to fill the engine room quickly with ammonia fumes is exceedingly hazardous to the employes. A brief exposure to the fumes would be sufficient to overcome persons in the room, and unless immediate assistance were given, death from suffocation would quickly follow. It is essential, then, that the system be arranged in such a way as to permit the employes to shut off the ammonia supply quickly, from any one of 3 or 4 widely separated points. In addition to this, oxygen helmets should be distributed about the room at convenient places, so that the employes may procure them quickly in case a leak or rupture occurs. Equipped with these helmets, the men will be immune from the dangers of the fumes for a short time, and will be able to make temporary repairs.

It is customary, when installing a refrigerating system, to test it under air pressure before it is charged with ammonia. This practice is commendable if it is properly carried out; but if it is done in a careless manner, by inexperienced men, it may result disastrously. The principal sources of danger are those due to a break of some defective part of the system, or an explosion brought about by the ignition of oil-vapor or other inflammable impurities. The various parts should be tested by the manufacturer before shipping to the point of installation, and they usually are. Shocks received during transportation or installation may cause a defect in some part of the system, however, and the joints may also be poorly made. For these reasons extreme care should be taken to guard the workmen during the test. It is customary to lubricate the cylinder walls of the compressor with oil before starting the test, and more or less of this oil is forced into the piping by the compressor, and collects in pockets. As the pressure is increased, more and more heat is generated, the oil vaporizes, and if the rise in temperature is sufficient, an explosion results. Lubricating oil having a low chill-point is desirable for regular use in refrigerating plants; but most oils that fulfill this requirement have a low flash-point also, and they are therefore dangerous to use in an air-pressure test. Low chill-point oil is not so essential as high flash-point oil during the test, because the higher the flash-point the less is the danger from explosion.

A thin coating of lard oil should first be applied by hand to the walls of the compressor cylinders, and the compressor allowed to run until the pressure reaches 100 lb. or more. The compressor should then be stopped long enough to cool down, after which it should be started up again and operated until 40 or 50 lb. of additional pressure is obtained. It should then be stopped again, and when sufficiently cooled it should once more be started, but at reduced speed, and stopped whenever the discharge pipe becomes hot enough to be uncomfortable to the hand. If these precautions are taken there is little chance of an explosion from internal causes during the test. The men should be kept away from the apparatus as much as possible, however, as there is always a possibility that an accident may occur through the failure of an imperfect joint, or from unforeseen weakness in some other part.

Pipes less than 2 in. in diameter should not be used, except in single lengths. Pipes of smaller size than this are usually butt-welded, and are bent to the desired shape instead of being made up with fittings; and it should be remembered that there is always a possibility that an imperfect weld or an imperceptible crack will open during the bending process, when long pipes of small diameter are used,—particularly if the bend is at or near the weld. No matter what size of pipe is used, it should be properly supported, and should be installed so that it will not be subject to shocks from any source whatever.

Carelessness is just as dangerous in a refrigerating plant as in other industries. An operating engineer who neglects to open the valve in the pipe connecting the charging pipe and the shipping tank containing the ammonia, at charging time, shows gross carelessness, and a man of this type is likely to hasten the charging operation by applying hot water or steam to the shipping drums. Naturally, the heat thus furnished will increase the pressure in the drum to which it is applied, and if the valve is closed there is no means of relieving the extra pressure except by an explosion.

At this point it is well to call attention to the great importance of keeping all valves in the plant in good operating condition. There are many valves in a refrigerating plant that are seldom used. The mere fact of their presence indicates that they have been installed for some purpose, but their usefulness is questionable (or, rather, their uselessness is a certainty) if they are not regularly inspected and tested. Rust in the stuffing-box gland and on the threads of the packing nut is a common source of trouble in a plant. The greater the accumulation of rust and the longer it remains, the harder it is to operate the valves; and when occasion arises to use them, after a period of neglect, it is often found that they act as if they were solidly cast in the piping.

Compressor accidents may be divided into 2 classes: (1) those due to the breaking of some part of the compressor itself, and (2) those occasioned by conditions not inherent in the construction of the machine, such as unusual pressures, explosions, or the presence of liquid ammonia in the compressor. Accidents under the first class include the breaking of valves, piston rods, and rings, or the rupturing of cylinder walls and heads. Valve breakage is the most frequent cause of compressor accidents, and is due principally to unnecessary wear, improper cushioning, or deterioration of the metal. It is evident that careful attention to the materials of construction, and to the design and installation, are necessary in order to keep accidents of this class at a minimum.

Accidents due to the rupturing of cylinder walls and heads are rare, and are usually attributable to faulty design and construction, or to a lack of proper consideration of shrinkage strains.

Piston rings formerly caused considerable trouble, but ordinary snap rings are now used with satisfactory results, so far as accidents from this cause are concerned.

Accidents under the second heading are not frequent, but they are likely to be much more disastrous. Those caused by excessive pressure may be avoided in considerable degree by requiring ample safety factors in the material, design, and construction of compressors. In addition to this, relief valves should be so installed that they will operate before an increasing pressure has reached the limit of safety. The discharge valve may accidentally be left closed and the machine started, and unless a relief valve has been installed it is certain that as the pressure increases, something must give way. If a relief valve is installed in a bypass, or in a connection made between the discharge-side pipe of the compressor in front of the stop-valve and the suction side of the compressor in front of the suction stop-valve, protection will be given against excessive pressure in the system as well as in the compressor.

However carefully a system is designed and installed, a certain amount of liquid is likely to accumulate, and its presence in the compressor is always a source of danger. The obvious remedy is to provide a properly located relief valve, of sufficient capacity to permit the discharge of practically all the liquid present before the piston reaches the end of its stroke. There are cases where considerable difficulty may be experienced in equipping compressors with such devices, but the greater safety gained is well worth the trouble.

Every steam engine should be provided with a safety stop, wholly independent of the ordinary governor. In case the governor fails to work properly and the engine starts to "race," the independent safety stop is supposed to operate as soon as the speed exceeds a predetermined limit, shutting off the steam, bringing the engine to a standstill, and preventing the bursting of the flywheel and other serious consequences.

The operating engineer of a refrigerating plant should remember that he is subject to many of the hazards that are to be found in the ordinary power plant, and also to some additional ones. For example, in compressing air he should never use a machine that has recently been used to compress ammonia; and in opening gage cocks he should stand at the side rather than in front of the gage glasses. Such precautions as standing at the side rather than in front of cylinders or compressors, and refraining from calking pipes or tightening up fittings, while they are under pressure, are generally understood, but often disregarded. It is particularly dangerous to calk joints or tighten nuts or fittings under pressure. Many fatal accidents have been caused in this way.

In the growth of any industry, dangerous situations arise that could not possibly be foreseen. This is one of the penalties of pioneer work. We have commented on some of the more common hazards in the refrigerating industry. No doubt, as the industry grows, new conditions, some of them having considerable elements of danger, will arise. Refrigerating engineers should have this possibility in mind at all times, and by calling on past experience endeavor to keep down the number of unforeseen dangers.—The Travelers Standard.

Narrow Belts vs. Wide Belts

By N. G. Near

I HAVE seen it stated that a narrow belt is just as good for transmission of power as a wide one, provided the narrow one is not stressed beyond the proper point. This is true. Where the distance between pulley centers is great I would always use as narrow a belt as can *safely* be used, so as to make the first cost of the belt as low as possible. But where the first cost is small, due to short distances, and where considerable power is to be transmitted, I would recommend a wider belt and lower resulting unit stress.

A wide belt does not "creep" as much as does a narrow one pulling the same load. Therefore, the power loss in the wide belt will be less and the danger of slip less, as usual.

The windage loss of a wide belt is greater, and the power required to bend it as it passes over the pulleys is greater, but in the long run the wide belt will generally prove itself to be the better investment.

(The long, narrow belt is subject to side sway and care must be taken to prevent its jumping the pulleys. —Editors.)

A practice that is fast gaining adoption in progressive power plants is the use of paint for the inner surface of steam boiler drums. The paint is said to afford protection against pitting. Silica-graphite paint is used for this purpose and for a number of years, the manufacturers of this paint have coated the steam drums of 5 B. & W. boilers developing 1800 hp. and, as a result, the drums are in almost perfect condition. In another instance, in a plant equipped with B. & W. boilers developing 8400 hp., the interiors of the drums were scalded, painted both above and below the water line and allowed 48 hr. to dry thoroughly. This treatment was repeated every 10 months and not only did it stop pitting, but where it had previously taken 6 men 7 days to clean the drums of one boiler, 2 men now clean them in a day. This latter experience is quoted from a letter of the Chief Engineer of the New York Life Insurance Co., in the April issue of Graphite.

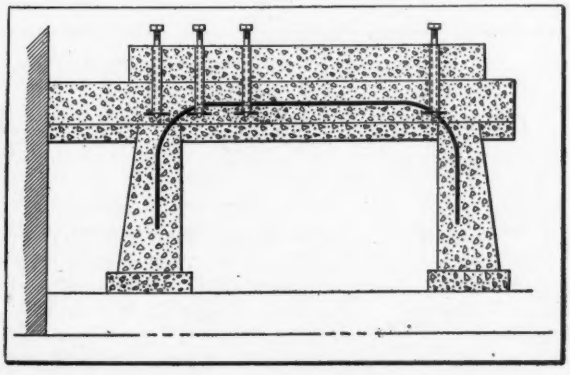
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Reinfored Concrete Engine Foundation

A NEW shop was built not far from my engine room, for which power was to be supplied by a horizontal, high-speed, cross compound steam engine. It was decided to build the foundation of re-inforced concrete, and the original plan was to make it one solid block of suitable dimensions. When an excavation was made for this purpose, it was evident that the soil was unfit for it to rest upon, owing to its soft and yielding nature; a sufficient quantity of it was removed to admit of installing a foundation that was large enough for all practical purposes. Several feet lower a firm bed of gravel was found; but if the whole foundation was carried to this depth, the block would be much larger than was actually necessary, making the cost excessive.

To overcome these objections and still provide a bed that would not settle, or vibrate in service, was the problem to be solved. The illustration shows the method



METHOD OF REINFORCING CONCRETE ENGINE FOUNDATION

adopted. A square hole was dug at each end, extending down through the unstable soil, until the gravel was uncovered. Into these holes concrete was poured until a substantial "foot" about 18 in. deep was secured. On each of these a pier was built, that was vertical on the inner side, and tapering on the outer side. The earth that had been removed was filled in and made as solid as possible.

A thick slab of concrete was then laid down on top of these piers, which extended to the solid wall on which the building rested. Bonds of 1¼-in. square twisted iron reinforcing bars were inserted in the piers, while the mixture was yet soft, and built into the horizontal slab. These bonds were located about 12 in. apart. Another slab was built on top of this, which was long enough to support the engine frame. Foundation bolts were set in pieces of pipe, so that they could be moved more or less to take corresponding holes in the cast-iron frame. This is necessary because it is difficult to locate these bolts in exactly correct position before the frame is set. An "eye" was formed on the end of each, and a piece of round iron inserted to prevent the bolt from turning.

The total mass of concrete in this foundation was the same as the original contract called for, but by changing the shape of it as shown, the benefits of a substantial gravel bed support were secured, and it has proved satisfactory in practice. W. H. WAKEMAN.

Cutting in Boilers of Unequal Pressure

I AM AWARE that it is against all theory of good practice to cut in boilers of a higher pressure with those of a lower pressure, but I have yet to be shown wherein the danger lies.

Let us postulate a boiler carrying 125 lb. and one carrying 100 lb. Then if we open communication between them, a state of inequilibrium is set up. Let us examine the manner in which these unbalanced forces tend to readjust themselves. The pressure in the low-pressure boiler being increased beyond the point corresponding to the amount of heat stored therein, ebullition immediately ceases. It does not again occur until the water has absorbed enough heat from the furnace, and by condensing a certain amount of steam out of the steam space, to bring it up to the temperature correspond to the new pressure.

Thus, the only effect on the low-pressure boiler is the quieting of the water, a process which is in no way dangerous. The high-pressure boiler is affected in a more objectionable way; as the pressure is lowered, the temperature of the water causes large amounts of it to flash into steam. This will continue until enough heat has been given up to correspond with the lower pressure. This supernormal rate of evaporation may possibly become so great as to cause heavy surging and water hammer in the boiler, but no sane attendant would throw his valves open at once. Common sense and respect for this pipe line alone would make him crack the valve and allow the steam to be wiredrawn. The period of time allowed for a balance of pressure to take place should be watched so as not to do this too suddenly. Under these conditions no danger can arise. The attendant will be in the habit of turning the steam into the main line very slowly, after shutdowns have occurred, and the line is cold. This habit will prevent careless handling of the main steam valve at all times.

We have in our factory one 300-hp. boiler operating at 125 lb., this works independently of our other boilers, which carry 75 lb. The high-pressure line is bypassed to the low-pressure line so that when the high-pressure

engine suddenly stops, the bypass can be opened just enough to keep the pressure even in the high-pressure boiler. The steam generated is wiredrawn down to 75 lb., and assists the low-pressure battery, the bypass acting as a reducing valve. If the high-pressure engine is not to be operated any more for the day, as often happens, then by slightly increasing the opening of the bypass valve the high-pressure boiler is very slowly allowed to drop to 75 lb., the fires being meanwhile slowed down and the draught stopped.

I am anxious to promote a discussion on this subject and will be pleased to hear from anyone who is shocked and pained by my immoral ideas. In our plant, a new 300-hp. boiler was installed. A safety valve, supplied by the makers, was purchased by them from a reputable firm of manufacturers. This valve had been set at the factory at 125 lb. and that number stamped on the outside.

When we got steam up for the first time, as the steam reached 124 lb. the valve began to hiss, and everything seemed proper.

Imagine my sensations when, at exactly 125 lb., the valve opened wide and roared, belching out not dry steam but a cloud of moisture fully as dense as what would issue from a blowoff pipe. The whole boiler and setting vibrated with the strain, and the surging of the water made a booming noise in the boiler which suggested that things were getting no better fast. Here was illustrated a case where the pressure was reduced too rapidly, and a dangerous state of affairs set up. Had the valve opened only enough to release the steam as fast as it was formed, there would have been no danger.

I grabbed a bit of 2 by 4, to use as a club, and rushing up the ladder, I clubbed the top of the valve spindle till I had driven it down somewhat, and the water in the boiler felt more like staying there. Then I let it blow to see how much pop had been allowed.

When the blowing stopped, I went to look at the column. That boiler had lost 30 lb. of steam and 8 in. of water in 3 min.!

The more I thought about that, the gladder I was that I had made my will the week before. I said to myself, "Never again!" I gave orders that no more than 100 lb. should be raised on that boiler, and the rest of the week I camped there and saw that it was done. On Sunday I took the valve off and replaced it with an old one of the same size, which I knew to work properly. Doubtless I could have changed the pop of the new valve till it worked properly, but to do so I would have had to "cut and try."

Had the makers set this 6-in. valve by testing it on a pipe line smaller than its full size, or had it been tampered with since it was turned out?

It is in the storeroom now, and there it will stay.

H. K. Scholefeld.

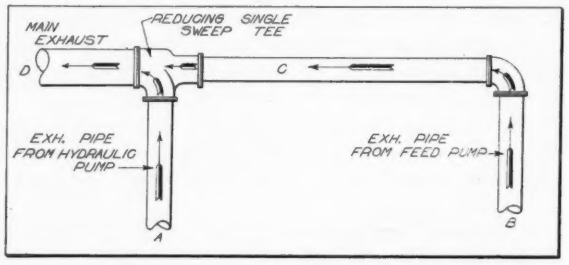
Massachussetts Engineers

In J. L. T.'s article in the May 15 issue entitled The Fallacy of Kinks at Times, it is unfortunate that the article was directed against Massachusetts first class engineers. It seems unreasonable that an amateur mechanic should have a better grasp of pump repair problems than a man who has put half a lifetime in the work. This article, I fear, is liable to give a wrong impression of Massachusetts first class engineers as a class who, as is well known, are sought by commercial men and manufacturers in all parts of the country, as evidenced by advertisements in our papers. This in itself is proof of the superior ability of these engineers who, because of their ability, have been the object of much criticism.

J. J. M.

Arrangements of Piping

In viewing the illustration which accompanies Mr. Palmer's letter, I notice that the individual exhaust pipes from the 2 pumps are different sizes, and that they connect into a larger pipe, which is correct in principle to a certain extent. It seems to me that there are at least 2 objectionable features, however, in the layout as given. The hydraulic pump connects into a tee, which is not the best connection that could be made; also, the main exhaust pipe on either side of the tee is the same in size, which tends to take as much



PIPING SCHEME FOR 2 EXHAUSTS INTO 1 MAIN PIPE

of the exhaust steam toward the feed pump as away from it. That part of the main exhaust pipe at the right of the tee connection belongs only to the feed pump exhaust pipe, and need only be the same size as the individual exhaust riser from that pump. This would tend to make the exhaust steam from the hydraulic pump all go the other way, through the larger pipe, toward the left. This, of course, is just what is required.

To carry out the idea still further, I submit the accompanying sketch. The introduction of the fitting known as a reducing single sweep tee will do much toward conducting the exhaust steam from the hydraulic pump in the proper direction, and away from the feed pump. The pipe connecting into the small end of the reducing tee need only be the same size as that of the riser from the feed pump. The pipe connected into the large part of the tee should be as large as the combined areas of the 2 exhaust pipes from the pumps. Suppose the exhausts from the feed and hydraulic pumps are respectively 1½ and 2 in. in diameter, then the main exhaust at the left of the tee should be at least 2½ in. in diameter to carry off the steam from the 2 pumps. Referring to the sketch, assume the pipe A to be 2 in. in diameter, B and C each 1½ in., then D should be at least 2½ in., and better if 3 in.

With the arrangement as shown, steam would not get over to the feed pump; the cost of making the change would not be prohibitive. Charles J. Mason.

Horsepower of Belting

IN THE June issue, I note that R. A. Dix criticizes my belt formula for treated belts. He supposes that I did not "go into the matter thoroughly." As it happens, I have studied belts, both theory and practice, with considerable carefulness, and in my opinion the best rule of thumb is that "each inch of width of a single belt, running 800 ft. per min., will transmit one horsepower." Now Mr. Dix's formula changed around slightly is exactly the same as the above rule of thumb except that he would use "600 ft. per min." instead of 800. My rule is, therefore, "safer" for all-around purposes, and that is what I have always been aiming at. This rule is good for horizontal belts, vertical belts, sloping belts, quarter-turn, cross, etc., and I especially recommend it for treated belts; for by its use, difficulty is seldom experienced in getting the belt to run slack or easy. You can eliminate the high tensions.

Another point that Mr. Dix apparently overlooked is that with belts well cared for and running slack, the arcs of contact on both pulleys will be greater than 180 deg. This holds for most drives regardless of the ratio of diameters of driving pulley to driven pulley.

I will not say that this rule is "better" than Mr. Dix's because the word "better" may imply cost, efficiency, life, etc. I merely say it is "safer," as comparison of the formulas will quickly show. I believe, however, the rule I have quoted to be best because it is so much used by belt drive designers.

There are many different belt formulas recommended by as many different writers. Some are complex, and some simple. The simplest ones are used most, and, as far as I can see, give just as good satisfaction as do the complex formulas. Belts run under so many different conditions that it is hard to make one rule hold for every condition. Hence the ample margin of safety in the above rule of thumb and its resultant popularity.

N. G. NEAR.

Vacuum and Temperature Discussion

TWO MEN were discussing the question of vacuum and one, whom we will call "A," asked the other, "B," whether, if for any reason the vacuum gage on his condenser pump became inoperative, he could start his condenser pump and know what vacuum he was keeping?

The answer B gave to A was this: "I would shut my injection valve and then open it a turn or so, enough to give my pump water, then start the pump, then the engine, and regulate the amount of injection water by feeling the discharge, as I would know by the temperature of the discharge whether the pump was getting enough water or too much water. If I wanted to tell the amount of atmosphere removed, I would have to immerse a thermometer in the discharge water from the pump and get the correct temperature, then with the aid of a steam table I could read the pressure due to the temperature reading, because every pressure of saturated steam, both above and below atmospheric pressure, has a temperature of its own due to said pressure."

Then A asked B: "Suppose the discharge water got warmer than the pressure called for, how could you explain that? And how could you know the pressure or the vacuum you had?"

B answered: "That could not occur, as the water would evaporate until the pressure in the condenser equaled the temperature."

"But if the temperature got lower than the pressure called for in the steam tables, as I have often seen it in practice," said A, "how would you explain that?"

B answered: "All condensers have air leaks and therefore one will see that a vacuum gage which shows a reading of 24 in. of mercury and the discharge water, instead of showing a temperature of 140 deg. as it should for an absolute pressure of 2.879, will show a temperature lower by 10 or 15 deg. So, in order to compensate for any air leaks, I would call a temperature at the discharge of 100 deg. at 26 in. of vacuum instead of calling it 28 in., as I should for that temperature, and in this way I would strike an average that would work out in practice."

In connection with this discussion, A says that B's statements are foolish and they will not work in practice. So I submit them to Practical Engineer for settlement.

JOHN H. ARMSTRONG.

Pump Devices

NOT LONG ago, I had general charge of some hydraulic pumps; by hydraulic, I mean pumps pumping pressure for hydraulic presses and kindred devices for pressures of 500 lb. or more.

Hard water was used, which had a corroding action in the water cylinders of the automatic pump governors; in fact, it was nearly impossible to get any satisfaction from automatic regulation and hand regulation was well-nigh impossible.

The piping leading to the water end of the pump governors was rearranged with a small tank made of a piece of 8-in. pipe close to the governors and with a U trap in the line to prevent draining the tank if the system was drained. The small tank was filled with oil, the governor packing renewed and the new device put to work. By this arrangement, nothing but oil reached the hydraulic end of the governors, resulting in freedom of action, and from that time we had no further trouble with the pump governors.

I was passing near the pump house of a railroad contractor's outfit and heard the exhaust of what I took to be a quick running small engine heavily loaded. I stepped into the place and was surprised to find that the exhausts came from a single-cylinder double-acting pump of the steam moved valve variety and, of course, without cranks and flywheels. About the only noise was the exhaust; there was no knock or jar about the pump or the piping, which was singular considering the speed and a single-cylinder pump. The attendant in charge noticed my incredulity and started to explain the trick.

The pump had a suction lift of about 5 ft. and a pressure lift of about 25 ft. through 200 ft. of pipe. The operator put his thumb over a spot in the suction pipe and, as soon as he did this, the pump commenced to knock very much as I had thought all pumps should do under like press of conditions. The moment that the finger was removed from the spot, the knocking diminished and in a few strokes entirely stopped. The spot on the pipe that the man covered with his finger was a

tiny hole not over 3/32 in. and, to make the hole still smaller, a small nail had been put in it, which was not a tight fit but still admitted some air.

The man said: "Enough is enough. If I let in any more air, the capacity of the pump will be reduced and the water will turn white as milk."

With this remark, he took the nail out of the hole and we watched the discharge, which was over the side of the tank. The capacity was reduced, as indicated by the reduced velocity at the end of the pipe, and the water did turn white.

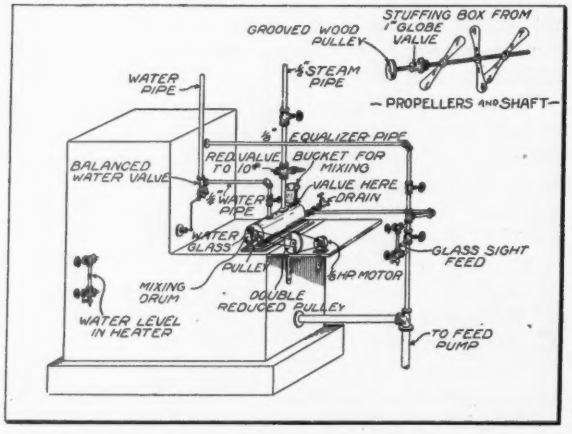
This is something new to me, as I have always been taught that the tighter you can get the suction the better things will work; but in this case, a little air was a benefit and it might not work with heavier suction lift or under different conditions. The water was ice cold.

SAMUEL P. BAIRD.

Feeding Graphite

ACCOMPANYING is sketch of a graphite feeder for feeding flake or powdered graphite into a boiler. I tried all kinds of apparatus and schemes, but they all failed, while this one has been in use now for more than a year and is still working perfectly.

The drum used was already on the heater, having been used for feeding caustic soda into feed water to prevent scale; but it also was a failure and besides was a constant danger to the boilers.



GRAPHITE FEEDER ATTACHED TO HEATER

The pulley on the end of the drum is fitted to ¾-in. shaft, which runs full length of the drum and partly through the opposite head, which makes a bearing for it on that end. On this shaft are 3 double propellers. In using this apparatus, it takes about 6 hr. to feed in about 2 lb. of graphite (flake or powdered), which is just as it should be fed. We have the worst water to scale that I have encountered in 30 yr. of handling steam boilers.

When I took charge, they were using a compound of 97 per cent caustic soda, which came very near ruining the boilers and it did no good; in fact, I afterwards took out pieces of scale that weighed 10 lb. Since using the graphite, the scale is coming off slowly but surely. The graphite works in under the scale and it drops off.

A. P. SITTON.

The Daily Friction Test

THE EDITORIAL in the June 1 issue—"The Daily Friction Test"—is a suggestion worth following wherever the power distribution system is either extensive or complex, and the indicator method, as suggested, will do very well.

Personally I have found the "flywheel momentum test" to be a good one. It can be applied every night on stopping work instead of each morning.

Simply instruct all machine operators to "run machines empty" at shutting-down time, instead of trowing them out, as is usually done. Then, with your watch, take the time required for the engine to come to a dead stop after closing the throttle valve.

When the friction load is so small that the flywheels will keep the plant running for a maximum length of time, you can be assured that the plant is running at its best as far as the friction end of the transmission is concerned.

For instance, take a plant whose Corliss engine runs at the speed of 80 r.p.m. It is equipped with a large, heavy flywheel. At 80 r.p.m. the flywheel has a definite quantity of energy stored in it. Shut the throttle valve instantly and the flywheel still contains that same amount of energy; but after the steam is shut off, the energy is gradually dissipated. It is evident, then, that if the friction load is lighter one day than another, the flywheel will keep the plant running longest on the day when friction is least.

In short, make the "stopping time" of your engine as long as possible.

N. G. NEAR.

Driving Shaft with Several Prime Movers

THE LETTER from Mr. Dickson, in the April 15 issue, prompts me to relate my experiences in driving a line shaft by several units. In our plant we have a 150-hp. Corliss engine, a 60-hp. Fairbanks-Morse oil engine, and 2 water wheels rated at 130 hp. each, one geared to the shaft, the other equipped with rope drive. All of these units drive the same shaft, which runs the ice plant and generator. The prime movers are put into operation as load requirements demand and frequently all are running. Under this condition, each unit takes its share of the load in proportion to its rating. As peak load comes on, I gradually bring a new unit into operation and seldom note a flicker in the lights when it is thrown in.

F. R. BAWLBY.

Mixed Fuel Reduces Clinkers

NOT LONG ago I was using large size anthracite coal for firing boilers and had an endless amount of trouble with clinkers. We tried out the scheme of mixing the coal with coke from the gas plant and have found it quite successful in reducing the amount and size of clinkers. If you are experiencing trouble with clinkers this scheme will no doubt aid you in keeping fires in good condition.

CHAS. E. BRACKETT.

THE USUAL OUTING GAMES of the Engineers' Blue Club of Jersey City, N. J., will take place Sunday, July 11, 1915, at Midland Park, Grant City, Staten Island. Breakfast served at 11 a. m.; dinner served at 5:30 p. m. Field events, 12:30 to 5 p. m.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Boiler and Pump Kinks

WE HAD to replace a fuse plug in our 150-hp. Atlas water-tube boiler, and the ¾-in. pipe threads were so badly worn that we had to cut a larger thread in the drum in order to get a safe job. All engineers who have worked in the space between the tubes and superheaters know there is little room for tapping a hole with an inch pipe tap, so you can understand the difficulty of the work. The hole had to be reamed out and then tapped, and as the man could not get sufficient leverage to work the tap with a 14-in. wrench, and a larger size would be too large for the space, some means had to be provided to furnish power.

A rope was secured to the end of the wrench handle and 2 men on the outside would pull when the man inside would get the wrench in position. This method was entirely satisfactory after the tap was started.

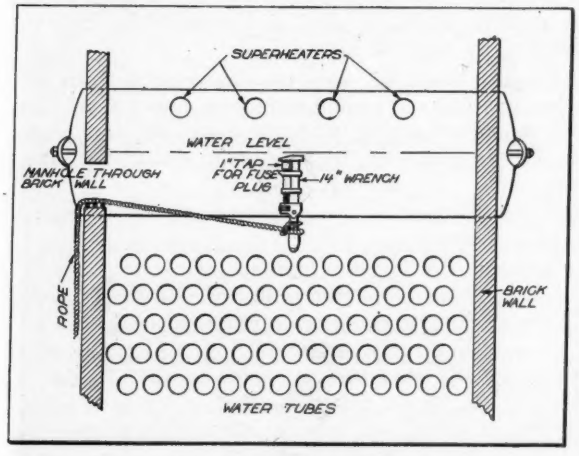


FIG. 1. TAPPING A HOLE IN CLOSE QUARTERS

We have had considerable trouble with our boiler feed pump which is a 4 by 2¾ by 4-in. Worthington duplex. On examining it we found that the bronze lining inside the water cylinders had worn badly. The stroke of this pump originally was 4 in.; but, owing to its worn condition, there were shoulders in each end where the packing would strike at each stroke. This would tend to shorten the stroke as well as destroy the packing, especially after new packing was put in. This short stroke condition prevented the pump's delivering the amount of water that it formerly did, and something had to be done because the pump did not keep the boiler supplied; and as we are using the return water from our heating system there was a lot of good water lost also.

After the engineer took the pump down, he decided to bore out the bronze lining of the water cylinders in order to make the diameter the same and do away with the shoulders at each end. After taking a piece of shafting and making a boring bar, the pump was put on a lathe and the lining bored out.

The boring was nicely done and was true in the center. But here comes the trouble: When the pump was assembled again it would barely run; after a short while it would stop and refuse to budge with 80 lb. of steam on the boiler and throttle wide open. The engineer looked around and everybody was looking at him. There were looks of doubt, some of despair, looks of "I told you so," none of care; but this engineer having been a close student in the school of experience, decided that this pump must run, and proceeded to work to that end.

The first thing to do, of course, was to find what the trouble was, which was soon done when the pump was taken apart the third time. The borings in the bronze

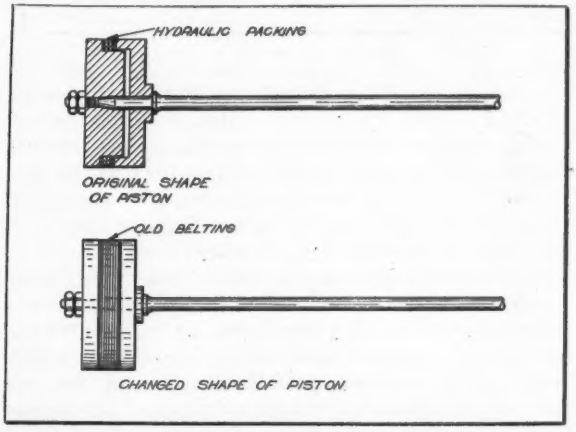


FIG. 2. PISTON PACKING CHANGED FROM HYDRAULIC TO OLD BELTING

linings, though fairly smooth, were not smooth enough for easy operation of the pistons back and forth in the cylinders. The pump was again carried to the shop and the water pistons turned on a lathe so that an ordinary lap piston ring could be made to fit each piston. These rings were made of an old wagon wheel bushing and purposely made very thin, so they would wear the bronze lining smooth, but not too rapidly. The pump was then put back in place and run for 2 weeks with these rings in it, and it pumped more water with the piston rings than it did just before it was taken down. Then as the linings were worn smooth by these rings, the rings were taken out, and as we had been buying a lot of hydraulic packing to fit the pistons as they were made at the factory, we decided to change the shape of the pistons so we could use old rubber or cotton belting. This pump

is now making 4-in. strokes every time and is pumping the required amount of water, which is about 30 gal. a minute.

The rocker arms on this same boiler feed pump continued to work loose and no key that we put in would hold them tight any length of time. I decided to drill out the key ways in the rocker arms and shafts, tap them and fit a set screw to them. This settled the trouble for all time and also made it easier to remove the rocker arms when necessary, because all you would have to do would be to take the set screws out, which is considerably handier than removing a key. I recommend this method to all who have trouble with short keys and where it can be applied, provided the drilling and tapping is carefully done.

Our vacuum pump took it upon itself to act cranky or not act at all, so something had to be done to make it work. It is a Knowles simplex, with a walking beam

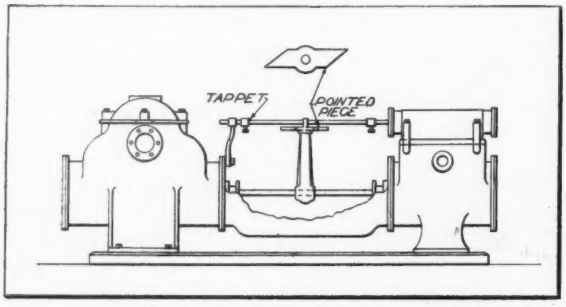


FIG. 3. REPAIR TO PUMP VALVE GEAR

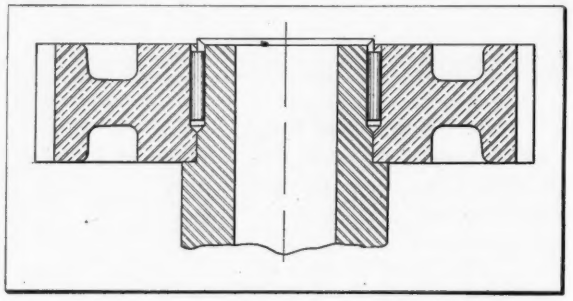
style rocking bar. This bar had been broken and patched and did not work true, owing to this condition, as well as being badly worn. What to do with it was a serious problem because, to get the best service from our heating system we must keep this pump going. After working with it a while, our engineer took a hammer and chisel and cut off the lug that supported this rocker bar. Then, having burned his bridge so that there would be no coming back of the rocker bar, the following method was worked out, and is still giving good service. On the upright piece or crosshead, a piece of soft steel was riveted. This piece of steel was pointed at each end, the ball joint was disconnected and in each tappet a bolt was screwed and when the piston made its stroke the pointed shaped piece pushed the tappet to one side by rubbing against the bolt at that end. This caused the valve piston to rotate and the ports engaged, and the steam would drive the valve piston and valve which would reverse the steam and cause the piston to move in the opposite direction, and at the end of each stroke the same operation would take place. This pump is giving good service and has been ever since the change was made, over a year ago.

ROBT. L. CAMPBELL.

Fastening a Hub to a Wheel

THE ILLUSTRATION shows a method used for fastening a hub to a large wheel, which is of value on some classes of repair work. The hub is made a driving fit and after forcing it into place in the wheel, a number of holes evenly spaced are drilled from one end as shown. The size and the number of holes required depend upon the size of the hub and wheel.

Cold rolled steel pins are driven into place in the holes and the projecting edge of the hub is then riveted over. This method of fitting a hub is very satisfactory where the wheel is transmitting the power through the



A METHOD OF FASTENING A HUB TO A WHEEL

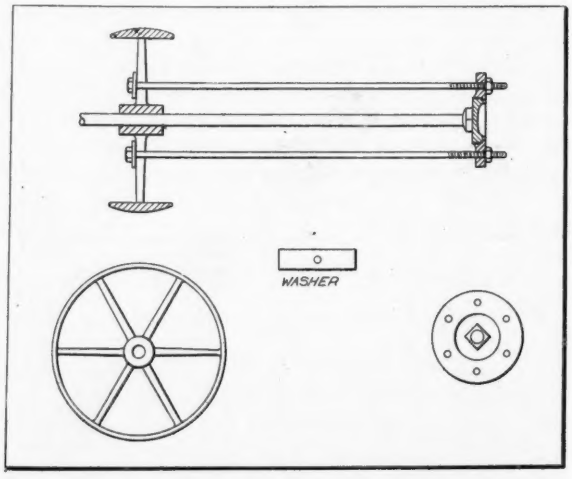
hub, as the full length of all the pins takes the load being transmitted. It also does away with the necessity of cutting keyways and fitting keys, making it possible to do a job of this kind in a comparatively short time.

JOHN LEAFSTROM.

Removing Pulley from Shaft

A 24-IN. CAST-IRON pulley having 6 spokes, was frozen onto the 2⅞-in. shaft at a point 30 in. from the end, and we removed it thus:

A 6-in. standard pipe flange, having 6 ¾-in bolt holes, was dug out of the storeroom, also a 6-in. plug. We screwed the plug into the flange as shown, and backed the square of the plug up to end of the shaft;



METHOD OF REMOVING PULLEY FROM SHAFT

6 bolts ¾ in. diameter were run through the bolt holes and between the spokes as shown, with square washers to back against the spokes. When the nuts were drawn up, one at a time, the pulley soon got over its attachment to the shaft. The plug, having a round head, formed a rocking bearing, which equalized the bolt pull.

H. K. SCHOLEFELD.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Lining Up Engine; Slipped Eccentric

WHAT IS the most practical way to line up an engine?

2. How would you set a slipped eccentric without removing the valve cover? J. L. B.

ANSWERS

THE ONLY way to line up an engine so as to make a first-class job of it, is to remove the piston rod and connecting rod and run a line through it. Unless the engine has bar guides, or a single guide with a slipper crosshead, it is not necessary to remove the crosshead, as the string can be run through the piston rod hole in the crosshead.

Use a smooth fine silk or linen line which is free from knots or lumpy or frayed places and stretch it tight enough to remove the sag between targets located at the back end of the cylinder and outside the crank. By means of light pine sticks of a length of about ½ in. shorter than the radius of the guide barrel and cylinder with pins or fine smooth headed brads driven firmly in the ends, adjust the line so that it is absolutely central with the guide barrel. Don't "feel" too coarse, but have the length of the tram sticks so finely adjusted that you can barely touch the line, not see it move,—only feel it. This done, find out how much the cylinder is out of line with the guides as it stands, making note where the greatest amount is, etc., and if it is necessary to rebore, make an accurate note of the distance the several parts of the counterbore are from the line, and set the boring bar with this same relative distance. The rebored cylinder will be in line with the guides.

Before removing the line, rotate the shaft back and forth so that the crankpin barely touches the line and note whether the distance from the line to the face of the pin is the same at both positions; if not, adjust the outboard bearing until this is accomplished. Level the shaft if necessary, making sure that the shaft is not tapered where the level is placed. If there is no place on the shaft large enough to receive the level, and the wheel is known to run true, or pretty close to it, drop a plumb line from the top edge past the bottom and note if there is any difference. It is best to have a piece of wood of a known thickness under the line at the top, say, ½ in., so that the bottom of the line will have a certain amount of freedom in which to find its position, and if the measurement at the bottom is the same as at the top, the shaft is level.

With bar or other adjustable guides, it will be necessary to aline them to the string after it has been set in line with the cylinder, as in this type of engine, the cylinder is presumed to be the most stationary part and that to which all other parts should be adjusted for alinement.

2. Eccentrics do not slip unless the engine is running, in which case it is always imperative that the engine be in operation at the earliest moment, as perhaps a moment's delay would be vital, as for instance if a heat were being taken off in a foundry.

An engineer ought to see whether the eccentrics are marked as soon as he takes the position, so that if necessary to reset them, it will be a comparatively easy matter; however, this is not always possible, so it is a case of doing the next best thing. You can see that it is impossible to give a rule that is applicable to all conditions that may arise, so we will assume 2, and they will suggest a way on other types of engines.

In case an eccentric should slip on a plain slide valve engine having cylinder cocks, place the engine on the dead center, and after opening the cocks full, crack the throttle so as to admit a small amount of steam and back the eccentric up until the steam ceases to issue from the cylinder cock at the end on which the dead center is located.

Then advance the eccentric a small amount, say ¼ in. or so, for lead, and fasten it. Pry the engine off the center and go ahead.

With a single eccentric Corliss engine, place the engine on the center and open the indicator cock at the same end as the engine is centered on. Crack the throttle, and advance the eccentric on the shaft in the direction in which the engine is to run until steam issues at the indicator connection and fasten it there. Pry the engine off the center and start up.

If the conditions are very urgent and every minute means money made or lost, and assuming any kind of a single eccentric engine with a direct motion, that is, where the eccentric is in advance of the crankpin, no matter where the engine stops, make a good guess at a little over a quarter of a circle with the full part of the eccentric ahead of the pin, and fasten it there. It may not be right within 5 to 15 deg., but it will enable you to run. In all probability the engine will knock and pound, but it will keep the wheels turning for an hour or 2, and that is the main consideration.

With more complicated valve motions such as indirect or reversing motions, overhung and underhung wristplates, inside admission, etc., one cannot give any general rule. When you first get on a new job, learn your engines as soon as possible, so that you may be able to meet emergencies with promptness.

G. H. WALLACE.

FOR ORDINARY pipe joints use a mixture of plumbago and vaseline instead of white lead. It is claimed this mixture does not dry out and the joint is easily separated when needed.

Clearance Adjustment

I AM in charge of an 18 by 42-in. Corliss engine, the piston rod of which is keyed to the crosshead. How can I adjust the cylinder clearance? T. L. H.

A. From what you say in regard to your engine, I presume that the piston is put onto the rod either with a shoulder or a tapered fit. In either case, the piston cannot be changed in its position on the piston rod.

In that case, with the piston rod keyed into the crosshead, the only way of changing the clearance is by changing the length of the connecting rod.

Assuming that there are liners in the ends to take up wear in the brasses, the length of the connecting rod can be changed by putting these liners either inside or outside of the boxes. In this way, the clearance may be adjusted. A. L. R.

Cooling Condensing Water

I HAVE CHARGE of a DeKalb ice machine. The water leaves the condenser at 95 deg. and goes to a water softener, and from there to the hot water system, but we use only about ¼ of the water, while the other ¾ is wasted. As we have to buy the water, I am anxious to save what I can. We have no air cooling tower, but there is a 100-gal. tank connected with the brine coils, and a small duplex pump in connection, so it would be an easy matter to make the proper connection and use the water from the condenser over and over again. In that way we could save the softened water, which now goes into the sewer.

What I want to know is, will it pay to cool the water with brine? The machine is 6-ton capacity.

O. D.

A. It will not pay to attempt to cool the condensing water with brine which has been refrigerated by the ice machine. It would be a case of working in a circle. First, the heat is taken from the brine by the ammonia and given up to the condensing water, and then the water giving the heat back to the brine.

In a plant of 6-ton refrigerating capacity, about 18,000 gal. of condensing water is circulated in 24 hr. The amount wasted in your plant is about 13,500 gal. To cool this amount from 95 to even 85 deg. F. would take ½ the capacity of the ice machine, or about 3 tons.

The proper thing is to install a cooling tower. This can be made cheaply, and if placed on the roof will easily cool the water from 10 to 20 deg. F.; if the water goes to the top of the tower at 95 deg. F.

If the double-pipe type ammonia condenser is used, the pump will take its suction from a shallow pan under the cooling tower and discharge through the condenser, then back over the tower. The pump will be discharging against a head only equal to the height of the tower, so the cost of operating the pump is little. A centrifugal pump belted to the ice machine is best for this service.

A. G. SOLOMON.

Power Required for Ice Machine

WHAT IS the horsepower required for Allen dense air ice machine or other machines of that type per ton of refrigeration, as compared to an ammonia machine of the compression type? R. L. M.

A. In regard to the matter of power used for the dense air ice machine, which, as far as we know, is the only machine of that type, there seems to be little accurate data available.

In one record of a test of such a machine on the U. S. S. Virginia, the capacity of the plant was 3 tons; compressor dimensions—9 in. diameter, 14 in. stroke; expander—7½ in. diameter, 14 in. stroke; steam cylinder—10 in. diameter, 14 in. stroke. The plant was operated with steam pressure of about 150 lb., but pressure actually entering the steam cylinder was about 50 lb. with the usual 26 in. vacuum. The test shows nothing as to steam consumption or the engine power required, giving simply the different temperatures in the system and the method of operation of the plant.

We find a statement in one place that the dense air compressor, on account of the large clearance required and the friction of the large cylinders, has an efficiency only 33 per cent that of the theoretical, which would indicate that it is a much less efficient machine than the ammonia compressor and is used only because of the entire safety from unpleasant effects in case of a leak on board ship. A. L. R.

Remedy for Hot Bearings

WHAT CAN I do with a bearing which becomes so hot as to be beyond one's control? SUBSCRIBER.

A. This is a question that you will readily understand, cannot be answered with definiteness owing to the great complexity of conditions that govern each and every case of the kind. Some plants can be shut down with impunity, and are, every time a bearing gets warm enough that the hand cannot be held on it; at other plants, hot boxes are looked upon as a part of the daily routine, for to shut down the plant is an unpardonable sin.

In flour mills, rolling mills, ocean liners, etc., the wheels are kept turning as long as there is the slightest chance of doing so short of destruction of the bearing. Rolling mill engines are piped for water which flows continuously on every bearing as a rule, to prevent excessive heating. This is marine practice also.

In stationary plants outside of the rolling mills, this procedure is not possible, for obvious reasons. In case of a main bearing of an engine, for instance, use cylinder oil, or a mixture of this and a little graphite flour, or sulphur or powdered mica. Castor oil is an excellent substitute for cylinder oil to mix with these 3 ingredients, but is usually not at hand and is more expensive. These 3 ingredients, mixed with engine oil, will usually reduce the trouble considerably if more convenient than cylinder or castor oil. Gas engine oil (for internal lubrication) also is good.

If a babbited box, and it begins to spatter or run, slow down at once if you possibly can, but not stop entirely, as the dry, smooth shaft might solder to the bearing. Let the engine run slowly, using extra lubrication as above, and slack up on the bearings, as the shaft, expanding with the heat, increases the friction still further.

In case of a crankpin box, increase the flow of oil through the center oiler if one is provided, or through

any other means possible; for if the babbit begins to "wipe," it is liable to get into the oil holes and stop the flow of oil entirely.

While the writer has never seen it done, he has been informed by experienced engineers, that common salt thrown into a main bearing through the handhole, will reduce a hot bearing as quickly as anything else, though the course of reasoning for such treatment could not be given. GEO. H. WALLACE.

Annealing and Hardening Set Screws

I WANT TO cut the heads off about 250 set-screws and then cut a slot in them so as to be able to turn them with a screw-driver instead of using a monkey wrench.

How can I soften these screws so as to be able to work them and then reharden them? P. McN.

A. The way to draw the temper in the set-screws, is to heat them, in a forge fire, to a red heat, then lay them aside and let them cool slowly. This process is called "annealing," and will draw the temper of the steel.

After you have finished work on them, you can reheat them to a red heat, and let them cool until they are dark blue, then plunge them into cold water. The quick cooling gives the temper.

The chief difficulty will be in getting them too hard, after you have finished working on them, which would make them brittle, so that the slots would be likely to break out in setting them up. Your best method will be to try a few and see how it works, noting the color at which you plunge them, as different steels act differently during the tempering process, and no exact directions can be given. The color is an indication of the hardness. A. L. R.

Transmisson Line Economics

CORRECTION OF ERRORS IN FIGURING

IN THE answer by Mr. Johnson on Transmission Line Economics, June 1 issue, p. 553, we regret to find, on checking up the computations, some serious errors that were not discovered in editing the article.

To go into the reason for the calculations, one horsepower is equal to 746 watts, or 0.746 kw., since a kilowatt is equal to a thousand watts. Multiplying 90, therefore, by 0.746 would give 67.14 kw. instead of 82. This is the actual energy which must be delivered by the transmission line, and assuming that the power factor is 80 per cent, or 0.80, the kilovolt-amperes will be found by dividing the actual power delivered by the power factor. Dividing 67.14 by 0.80 gives 84 as the kv.a. to be carried by the transmission line. This would be 84,000 watts, and dividing by the e.m.f. to be transmitted, 5000 volts, would give 16.8 amp. to be handled on a single phase system.

Assuming a 10 per cent loss in the line, which is common practice, would mean a drop of 5000×0.10 or 500 volts, and it would be necessary to apply 5500 volts at the generator end of the line in order to get 5000 volts at the motor. Since the line is 10 miles long, it will be necessary to have 2×10 or 20 miles of wire, and dividing 500 volts drop by 20 gives us a drop of 25 volts per mile of wire. Dividing this again by 16.8, would give 1.485 as the ohms resistance per mile for the transmission wire.

This takes no account of the inductance loss, but for a line of this length, and this amount of current, the inductance loss could be neglected without serious error.

From a table of the properties of copper wire, it is found that a resistance of 1.485 ohms to a mile would lie between No. 4 and No. 5 wire.

Taking, now, a 10,000-volt transmission, the 84,000 watts divided by 10,000 would give 8.4 amp. Dividing 25 volts by 8.4 gives 2.975 as the ohms per mile for a 10,000-volt transmission. The wire table shows that this lies between No. 7 and No. 8.

As stated, these sizes would be rather too small to use in a 10-mile transmission circuit, on account of the mechanical weakness of the wire. As assumed, we might, therefore, use a No. 6 wire, which has a resistance of 2.0824 ohms per mile.

To construct a line for 10,000 volts would require much more expensive insulation more careful construction and a greater amount of safeguarding of the line against accidental contact, as well as more expensive lightning protection at both main station and substation.

As a matter of experience, therefore, the 5000-volt line, for this amount of power to be transmitted, would be the more economical, and in order to save in first cost, we might use No. 6 wire for the line, and accept a heavier than 10 per cent loss.

If we take a No. 6 wire, 10 miles in length, the resistance would be 20.82 ohms. Multiplying this by the square of the current for a 5000-volt transmission, we will get 5880 watts per wire as the loss, or for the 2 wires of the line, 11,760 watts. Dividing this by the power furnished, 67,140 watts, we get 0.175, or a 17.5 per cent line loss. This is quite a considerable loss, but might probably be justified by the lessened expense of construction of the line. This would be the loss for a single-phase system.

For a 3-phase system, the current in each wire would be $16.8 \div 1.73 = 9.72$ amp. per phase, and multiplying the square of this by the resistance of one wire, 20.82, we would get 1970 watts as the loss per wire, or $3 \times 1970 = 5910$ watts as the total for the 3 wires.

This is approximately $\frac{1}{3}$ the loss for a single-phase system, while on the other hand, since the mechanical requirements call for a No. 6 wire anyway, the copper cost for the transmission line, as well as the cost for insulators, would be 3 times as great; the cost of labor for the line construction would be approximately 3 times as great, and the poles would have to be a good deal heavier, and would probably have cross arms provided, whereas in the single-phase line, it would be possible to mount the wires one above the other on the pole, without using cross arms.

For these reasons, as Mr. Johnson has stated, it would be cheaper, in this instance, to use the 5000-volt single-phase transmission than any other form. Figuring out of the exact cost, or comparison of costs, as he has stated, would necessitate knowing the price of materials delivered on the transmission line, the cost of labor, the nature of the ground over which the line passes, and other data, which would affect the actual cost of construction, and therefore no estimate can be made.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Answers to Massachussetts Examination

QUESTIONS PUBLISHED JUNE 1.

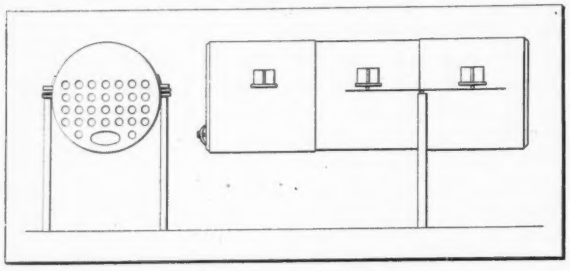
THE DISTINCTIVE features of Stirling boilers are 3 steam and water drums in a single boiler above the gas passages connected by curved tubes to the mud drum below the gas passages.

2. I would put the equalizer on as follows; use 2 supports, one each side of the boiler, with a roll on top (these supports are between rear and middle brackets) and a flat piece of steel on the roll long enough to reach under both brackets, with a roll under each bracket. The use of it is to keep the strain equal on the boiler, if the rear wall settles instead of a strain being on end of boiler the equalizer will take care of it.

3. Figure the weakest joint using the Mass. State law.

$$\frac{t \times \text{T. S.} \times \%}{R \times \text{F. S.}} = \text{S. W. P., or safe working pressure.}$$

t = thickness of shell; T. S. = tensile strength; R = radius; F. S. = factor of safety, which varies from 4.5 to 6; % = efficiency of joint.



EQUALIZER ON BOILER

4. The Heine steam drum is figured the same as question No. 3.

The safe working pressure of the water leg of a Heine boiler is found by the formula below:

$$\frac{C \times (t+1)^2}{S^2 - 6} = \text{S. W. P.; for hollow staybolts,}$$

same as in the Heine, add to S the mean diameter of staybolt.

S = maximum pitch of staybolt in inches; C = constant 66; t = thickness of plate in sixteenth of an inch.

5. The allowable stress upon a hollow staybolt of weldless steel = $6283.2 \times (D^2 - d^2)$ lb.

In which D = diameter at root of threads.

d = inside diameter.

Allowable steam pressure on a stayed surface =

$$P = \frac{66\,(t-1)^2}{S^2 - 6}.$$

In which

P = steam pressure in lb. per sq. in.

t = thickness of plate in sixteenths of an inch.

S = maximum pitch of staybolts in inches.

Stress upon a staybolt = $P \times S^2$.

The size of bolt must be such that $6283.2 \times (D^2 - d^2)$ is greater than $P \times S^2$.

With hollow staybolts with holes ½ in. or over add the mean diameter to the pitch of solid bolts to get the maximum allowable pitch.

6. The Heine boiler uses the dependent type of superheater made by the Heine Safety Boiler Works.

7. I would lay out the cranks at 120 deg. apart around the shaft, which would give as nearly as possible a uniform torque.

8. By referring to the answer to 5 we readily see that

$$D^2 - d^2 = \frac{P \times S^2}{6283.2}.$$

9. The initial pressure would be calculated precisely as with a compound engine dividing the load equally between the intermediate and low-pressure cylinders.

$$P = w \div a\,[l'\,(1 + \text{hyp. log. } R'') - c\,(1 + \frac{r-1}{R'})].$$

P = Initial pressure, pounds absolute

w = work per stroke in foot-pounds = hp. × 33,000 ÷ (2 × r.p.m.).

a = area of intermediate cylinder.

l′ = period of admission plus clearance, in feet.

R″ = actual combined ratio of expansion in the 2 cylinders together.

c = clearance at each end of the cylinders, in parts of the stroke, in feet.

r = ratio of the capacity of the low-pressure cylinder to that of the intermediate.

R′ = actual ratio of expansion in the intermediate cylinder.

10. A 3-stage turbine is where there are 3 rotors, and steam passes through the first rotor and stationary blades to second stage and then to third stage.

11. 45 per cent would be sufficient.

12. If the bag was not very bad, have it heated and driven back; if too bad, cut out and put on a hard patch.

13. If the condenser is at correct height, water can not get back into engine unless the discharge pipe is choked or clogged somewhere.

14. Receiver and reheater combined also snifting valve. The reheater will make the steam drier, also in some places live steam is entered in order to keep initial pressure to intermediate cylinder equal.

15. Weigh all coal after boiler was steaming till end of test, weigh all water during same period; the weight of water divided by pounds of coal = apparent

evaporation per pound of coal as fired. Keep the fire the same all the time, also water level.

16. To give larger grate area, thereby increasing the power of the boiler.

17. Without a gage, vacuum can be measured by the height it will lift water or mercury in some form of U-tube.

18. To determine the safe speed of a flywheel or strength: w = wt. of 1 cu. in. of material; T. = safe tensile strain; safe speed = $1.6 \times \sqrt{\text{T.}} \div \text{w}$ = velocity of rim in feet per second. T. = 6000 lb. for cast iron.

19. I would keep engine running until I could open the atmospheric exhaust and close the valve to condenser, then I would shut down and go to look after the vacuum pump. In fact, exhausting to atmosphere when running condensing in shutting down is the best way. W. N. L.

Calculation of Current Flow

THE ACCOMPANYING diagram shows the connections of the 2 storage batteries and resistance as given in the problem on page 556 of June 1 issue.

I assume that the voltages given are the intrinsic electromotive forces of the cells which, of course, must not be confused with values which represent the difference of potential of the terminals.

The drop in potential from A to B will be represented by symbol V.

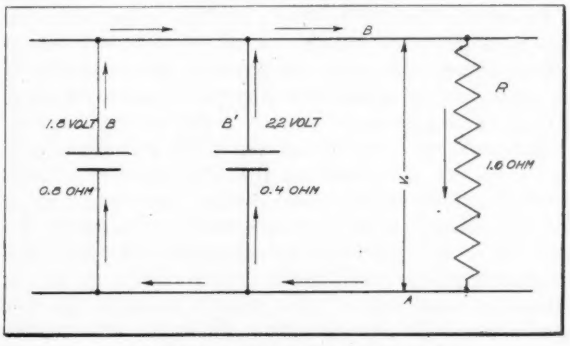


DIAGRAM OF ELECTRIC PROBLEM

Then I_1 = current flowing through B'.
I_2 = current flowing through B.
I_3 = current flowing through R.

$$I_1 + I_2 = I_3.$$

$V = 2.2 - .4I_1$.
$V = 1.8 - .8I_2$.
$V = 1.6I_3$.
$1.6I_3 = 2.2 - .4I_1$ and $I_3 = 1.375 - .25I_1$.
$1.8 - .8I_2 = 2.2 - .4I_1$ and $I_2 = -2.75 + .5I_1 + 2.25$.
$I_1 - 2.75 + .5I_1 + 2.25 = 1.375 - .25I_1$.
$1.75I_1 = 1.875$.
$I_1 = 1.0714$ amp.
$V = 2.2 - .4 \times 1.0714 = 1.77144$ volts.
$1.77144 = 1.8 - .8I_2$.
$I_2 = .0357$ amp.
$1.77144 = 1.6I_3$.
$I_3 = 1.107125$ amp. JOHN C. SCHULTZ.

(Correct answers were also received from Harry D. Everett, Amos J. Carr, Earl J. Reddert and E. E. Kaicy. —Editor.)

Commutator Lubrication

IN REPLY to H. G. H.'s inquiry in the May 15 issue, page 503, and W. G. I.'s answer in the June 1 issue, page 557, on commutator lubricant, I will say that I believe W. G. I. is both right and wrong in his statements. Paraffin is a good lubricant for commutator on small machines where a high voltage is not carried, such as 110 volts; on machines of 550 volts, if much is used it gums the brushes, making them sticky and causing the machine to buck over. It will also gather all the fine particles of dust and copper dust on the commutator and cause arcing between the brush holders. I don't mean to say that paraffin is no good, but a little goes a long way. On machines that are slotted to keep high mica from causing sparking, paraffin is not a very good lubricant, as it collects in the slots with copper dust and short-circuits the segment which will burn holes in the commutator.

W. G. I. says: "It may get too thick on the commutator" and "We always keep the sand block handy."

That is right, and the condition is easily detected by the black greasy rings or spots; but, in regard to the sandpaper block, I would advise him to hide it. After a commutator has once been turned up and smoothed with sandpaper, the sandpaper should be kept off the commutator unless it gets rough. What is the use of getting a good gloss on a commutator if sandpaper has to be used to clean it? Sandpaper wears the commutator away faster than service will.

Machines that have paraffin used on them should be washed off with gasoline when they get dirty or thick. The brushes should be gone over at least once a week to be sure that none are sticking.

I would suggest that H. G. H., if he has a large machine, use a little clean light engine oil or vaseline. This can be applied by making a swab with a piece of clean rag on a stick about 18 in. long. Dip the rag in the oil and let the excess oil drip off, then run the swab across the face of the commutator. This will clean as well as lubricate the commutator. If this, or vaseline applied in the same way, is used once a day, a good brown gloss will soon appear. After a good gloss has been obtained, oil or grease the commutator about once a week and clean it with gasoline when it gets dirty.

Take all precautions to stop sparking at the brushes; if the causes and remedies are not known, any good book on d. c. motors or generators will state the causes and a good idea is to stagger the brush holders; this will have a tendency to make the commutator wear smooth and even, otherwise it will wear in ruts, if the commutator has been turned down. The brush holders should be lowered to within ⅛ in. from the commutator to avoid chattering and sparking at heavy load. Brushes should fit the holders as neatly as possible to allow a free sliding movement. R. G. CURREN, JR.

TO PREVENT bronze bearings from running hot, flow a mixture of washing powder and water through the oil cups while they are opened as wide as possible, and the machine running light without any load. The fluid as it comes through the bearing will be very black. Run about 1 pt. of this mixture through and then follow with clear water to wash the bearing out clean. This will make the axle and bronze boxes smooth.—Exchange.

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Load Factor and Plant Factor

The efficiency of a plant, machine or system being largely a comparative quantity, it is absolutely essential that all terms, measures and expressions pertaining to power house operation be clearly and universally understood. If this be not so, one of the greatest aids in improving power plant efficiencies is in large part sacrificed, for without a clear understanding of all terms the operation of various plants cannot be compared and the benefits to be derived from the experience of others becomes more difficult, if not well nigh impossible. Most power house terms are pretty well generally understood, it is true, but there are still certain expressions that apparently have a popular double meaning—i.e., terms which mean one thing to some and quite a different thing to others. This is inimical to the best results, for confusion and misunderstandings are bound to occur. A horsepower-hour, for instance, must mean the same in Alaska as in South America, or anywhere else. When reference is made to a horsepower-hour, it must be similarly understood the world over. Each term, expression or measure should generally be understood in like manner and this standardization of terms is one of the most important activities taken up by the national engineering societies. That body has standardized and clearly defined many terms and the decisions of the societies should unquestionably be generally adopted.

The societies' definition of "Load Factor" is the ratio of the average load carried by a machine, plant or system during a given period to the maximum load carried within that period. A very popular understanding of the same term is, however, the ratio of the average load carried during a given period to the normal capacity of the machine, plant or system. The societies' definition deals, as it should, simply with question of load, while the other understanding takes into consideration the question of capacity. The question of capacity is a vital one to any plant or machine, but it is a plant question not a power question. A plant, whether it be considered as consisting of a machine, a complete plant or system, must have a capacity sufficient to care for the maximum demands to which it may be subject, but that does not necessarily mean that the maximum requirements are the same as the capacity. The ratio between the average load and the rated capacity of the plant is very important consideration, however, and this is termed by the national engineering societies, the "Plant Factor."

The distinction between Load Factor and Plant Factor is an important one and should be generally understood and adhered to. Both terms are important, and when correctly used furnish much valuable information. For instance, it may be assumed that a certain plant has a rated capacity of 100 hp., that the average load carried is 25 hp. and the maximum load 110 hp. The Load Factor would be 22.7 per cent and the Plant Factor 25 per cent. Improvements in the demand for power might increase the average load to 55 hp.—the maximum load remaining the same. The Load Factor would then be 50 per cent and the Plant Factor 55 per cent, showing a considerable improvement in load conditions. This would be evident from both Load Factor and Plant Factor, but principally by the former as that took into

account both the increase in average load and that in the peak. Subsequently an increased peak might develop, increasing the maximum demand for power to 125 hp., while the average load was increased to 60 hp. The Load Factor would then drop to 48 per cent, indicating that the range of load was becoming undesirable, while the Plant Factor would increase to 60 per cent, apparently indicating much better operating conditions as it fails to take into account possible overloading of the equipment.

The Plant Factor does not measure overload conditions when the maximum capacity of the equipment is approached, unless the Load Factor is high, but is valuable as a measure of the efficiency of operation when the maximum capacity of the equipment is not attained by the peak. It shows up the inefficiencies of the various units comprising the plant and may be considered, therefore, as an efficiency measure. The Load Factor is just as valuable for, if the equipment is well proportioned to the demands, it gives warning of too severe load conditions and may be considered, therefore, as a safety measure.

Both Load Factor and Plant Factor are valuable terms, but their true importance can only be realized by care not to use them indiscriminately or to confuse their meanings.

News Notes

AT THE TIME of the International Engineering Congress in San Francisco, Sept. 16 to 25, excursions have been arranged as follows: On Sept. 18, a trip to the San Francisco high-pressure fire system, and the gas works and electric station A of the Pacific Gas & Electric Co.; also, a second excursion to the Spring Valley Water Works on the east side of the Bay. On Sept. 19, excursions have been arranged to the water works, storage reservoirs and pumping stations on the San Francisco peninsula, also to the delta lands of the Sacramento and San Joaquin rivers. Longer excursions have been arranged on the 17 and 18 to the Great Western Power Co.'s hydroelectric development on Feather river, and to the gold dredgings at Oroville; on the 18 and 19, to the Pacific Gas & Electric Co.'s development at Lake Spaulding, and the gold mines at Grass Valley, and an excursion from the 17 to the 19, inclusive, to the oil fields at Coalinga.

For those intending to make the trip to San Francisco from the east, a special excursion train has been arranged, which will leave New York at 7:45 p. m., Sept. 9, and arrive at Chicago at 10:55 p. m., Sept. 10; leaving Chicago at 11:55 p. m., Sept. 10, stopping for a day at Colorado Springs on Sept. 12, spending the day of Sept. 14 at the Grand Canyon, and arriving in San Francisco 9 p. m., Sept. 15.

Arrangements for accommodations on the train should be made with G. S. Harner, passenger agent, 1216 Broadway, New York City, and for any of the excursions during the period of Sept. 17 to 19, reservations should be sent to W. A. Cattell, Secretary of the International Engineering Congress, 417 Foxcroft Bldg., San Francisco, Calif. Those wishing further information in regard to the excursions can secure a booklet giving full details by sending a postal to Mr. Cattell.

A LARGE and representative gathering of the members of the commercial and manufacturing departments of the Sprague Electric Works of General Electric Co. recently met at the Hotel Marlborough, New York, for dinner, and organized the "Sprague Electric Club."

It will be the purpose of the Club to bring the salesmen, engineers, factory heads and other employes into closer personal contact and co-operation.

The Club adopted a Constitution and By-laws and elected a Board of Governors ond Officers, and plans were tentatively formulated for a series of meetings and events which are destined to stimulate the interest of the members in the new association.

ON FRIDAY, June 11, McIntosh & Seymour Corp. entertained the New York State Association of Stationary Engineers at its plant in Auburn, N. Y. This was part of the festivities in connection with the state convention, and was greatly enjoyed by all engineers and delegates present. Luncheon was served to about 150 delegates and ladies, at the Osborne House, and each guest was presented with a number of booklets dealing with the work of the Diesel engine. After the serving of the luncheon, which insured that the McIntosh & Seymour Corp. is a host whose hospitality will long be remembered with pleasure, the gathering adjourned to the works of the corporation, where they were shown a number of Diesel engines in operation and under test, and the entire plant was thrown open for the inspection and instruction of the engineers.

AUDIT AND APPRAISAL of the property of the Union Electric Light and Power Co. of St. Louis has been ordered by the Missouri Public Service Commission to determine reasonable rates to be charged for electric current in that city by the company. The Engineers' Incitation Club has made complaint that large consumers are favored and excessive rates charged for residential service and on this complaint the audit was ordered. The appraisal is to be completed by Oct. 1, 1915, and a legal battle is likely over the question of physical values vs. franchise and "good will" values, and the case is likely to be carried to the higher courts.

F. B. SENTER, the late president of The Franklin Oil & Gas Co., was born April 6, 1863; has been connected with the independent oil business practically all his life, or for the past 30 yr. He started in the oil business as salesman for one of the independents with headquarters at Cleveland. Later on, he became manager of one of the subsidiary companies of this independent, and retained the position until 1903, when he organized The Franklin Oil & Gas Co., becoming its treasurer and manager. Two years later he became president and manager, which position he retained until his death. Mr. Senter was an enthusiastic booster for the interests of the independent oil business. He had been ill for a period of 6 mo. At his death he was a member of the Knights of Pythias and the Cleveland Chamber of Commerce.

He is survived by his wife, Mrs. Kate O. Senter, a daughter, Mrs. Margaret Orchard, and a son, T. D. Senter, who is vice-president of The Franklin Oil & Gas Co.

O. M. E. S. E., At Toledo

THIRTY-FIRST SEMI-ANNUAL MEETING, JUNE 17 TO 19

AT the semi-annual meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, with headquarters at Hotel Secor in Toledo, a number of interesting and instructive papers were read, and the entertainment features of the meeting were exceptionally well planned, and speak well for the local committee which had this part of the program in charge.

The first day was spent principally in trips to some of the interesting plants of Toledo, and an outing at Toledo beach during the afternoon. In the evening, the first paper of the meeting was read, having been prepared by W. M. Dann and H. H. Rudd, taking up the topic of "The Use of Current Limiting Reactors." This paper dealt generally with the principles upon which the reactors operate, showing in what way this comparatively new piece of apparatus protects the machinery of the station, also the protection it affords to the service. The paper then describes the methods of connecting reactors in the circuit, the resistance allowable in the reactor, and the effect it has upon regulation. The paper will be given in more complete abstract in an early issue.

On Friday morning, those in attendance were taken on board the steamer State of New York for a trip to Put-in-Bay, and the papers were read during the trip to and from this island, made famous by Perry's victory of 1813.

BOILER ROOM EFFICIENCY

"ESTABLISHING and Maintaining Boiler Efficiency" was the title of a paper prepared by Geo. H. Gibson, but read, in his absence, by Mr. Alliger, and pointed out the methods which are now coming into almost universal use in power plants for developing higher efficiency in boiler rooms, and was illustrated throughout with a number of interesting lantern slides, which showed principally the methods of heating and metering boiler feed water.

He stated that, owing to the varying conditions in plants, coal analyses need in any case to be supplemented by practical tests, and moreover the steam boiler itself is the most practical form of coal calorimeter. He suggested that one boiler of a plant, while still continuing to perform its regular duty of supplying steam, be set aside as a special test boiler, that is, have it fitted up for the convenience of taking gas samples, and with pyrometer for determining the temperature of the furnace, the combustion chamber and the uptake. The most essential adjuncts are a feed water heater and scales for weighing coal and ashes. With a boiler thus arranged, a heat balance sheet can be drawn up, the losses can be analyzed, and experiments can be initiated to determine how much they can be reduced.

He then spoke of the various losses, and the amounts which are common in power plants, such as stack losses, short circuiting of gases through baffles, incomplete combustion, the personal element in firing, etc.

He then described in some detail the Cochrane metering heater, showing several different types and methods of connection, and also described the method used in testing these meters, in order that a high degree of accuracy may be obtained.

William T. Alliger then presented his paper upon "Increased Efficiency in Water Softening and its Influence in Boiler Plant Operation." This paper was, also, illustrated with a number of lantern slides, showing the effects of scale in various types of boilers, and illustrating the Sorge-Cochrane water softener.

He first spoke of the great strides being made to develop efficiency in power plants, and classified the equipment which is effective in producing higher economy, into 2 general classes: First, those units which, by the records they produce, serve as a guide to the operators for finding the losses and correcting them; second, those which actually increase the efficiency by their own operation.

The indicating equipment mentioned under the first class is the most recent development, and by its use, the boiler plant is placed under continuous test. Feed water heaters and water softeners are 2 of the most useful appliances included in the second class. By softening the boiler feed water, it was stated that the evaporation per pound of coal can often be increased as much as 15 per cent. Tube renewals and general repairs are cut down and practically eliminated, depreciation of boilers is decreased, labor charge for removing scale is eliminated, and a number of less important savings are involved. Accidents due to boiler explosions may, also, be reduced enormously by treating the water before it enters the boiler.

When scale forms in a tube, the resistance to heat increases. The metal is heated to a yielding point, and the tube is either pulled out of the header or blows out through a blister, and when one goes it generally carries several more with it.

Mr. Alliger then gave a brief history of the water softening process, and pointed out the effects of water softening on several different waters.

FIRE BRICK AND HIGH TEMPERATURE CEMENT

"FIRE BRICK for Boiler Settings" was the title of a paper prepared and read by Wm. A. Heisel, which dealt, in the beginning, with the composition, formation and location of fire clays, and their physical and chemical properties, also stating the impurities which are likely to be found in fire clays, and then gave a brief description of the method commonly employed in the manufacture of fire bricks.

He stated that with the present modern equipment, very much improved combustion occurs, much higher temperatures prevail, and higher ratings are obtained than were possible with the less intelligently designed and operated installations and boiler and stoker equipment of former years. Whereas some years previous a 50 per cent overload on a boiler was about the maximum to be expected, it is now not uncommon to see stoker-fired installations operated at a 100 to a 150 per cent over their commercial rating. Higher overloads do not necessarily mean higher temperatures than could be

obtained in boilers operating, say, about rating, but it is more reasonable to expect better combustion, and consequently higher temperatures, with boilers operating at least slightly above their commercial rating than at or below rating, because of the absence of excess air due to holes more likely to occur in a thinner fire bed on grates of liberal area. In a later issue this paper will be given almost in full, as it deserves more space than can be given to it here.

J. O. Boylan read a paper on "High Temperature Cement," in which he spoke of the difficulties encountered in cementing fire brick for use in boiler furnaces, and spoke of the various materials which have been tried out with more or less success. He then called attention to the recently developed bonding material known as No. 31 J-M high temperature cement, which is able to resist temperatures up to and including 3182 deg. F.

Safety to Workmen

A paper on the "Safety Problem, its Possibilities and Limitations," was read by J. M. Faris. He divided the problem of accident prevention into 3 main subdivisions, as follows: A, safeguards on machinery; B, safe operation, and C, safe men.

Under the safeguards on machinery, he spoke of the improvements in design, particularly of boilers, the materials used which practice has shown to be most suitable, the auxiliaries employed, and the practice of regular inspection. He stated that from personal experience, he found the best method of driving the governor mechanism of an engine is by the rope drive made up of at least 2 separate ropes of the very best kind of transmission rope obtainable. Also that the type of speed limit found most satisfactory is one in which the speed limit proper is rope driven, in the same manner as the governor, and when the critical speed is reached, a quick closing valve is operated by steam pressure and shuts off the steam supply. In addition to this, a number of push buttons are placed at convenient points.

Under the head of safe operation, he stated that there is need to instill into the employes the value to everyone concerned of "Safety First." Unless the man who runs a yard locomotive is himself interested in safety, there is liable to be an accident at some bad crossing, on account of his carelessness. If the power house operator fails to consider the safety of others, and closes some line switch just to see if it works, some men out on the lines may be maimed or killed as a result of his carelessness. There is hardly a place in a modern iron and steel plant where accidents cannot be caused by careless operation, and these accidents usually happen to the other fellow rather than to the guilty party.

Men are careless simply because they do not think. When the facts are placed before them, they appreciate what their carelessness may mean, the men immediately become interested. This knowledge can be imparted to the men in a number of different ways. Bulletin boards with safety pictures and data help some. A spirit of competition between various departments as to which has the lowest number of accidents also works out well. A method adopted by the Youngstown Sheet & Tube Co. is to have a number of safety committees throughout the plant, all reporting to one central committee. While the company saves by having accidents reduced, it is not very hard to make any normal man see that the greater loser, when a man is crippled for life, is the man himself, no matter what compensation he receives.

Another factor that may cause serious accidents is a defect of the operator himself. The engineer on a locomotive may be careful in operation, and yet, if he is color blind, a wreck may result. This applies equally well to other men in various classes of work. For instance, it is not fair to the man, or good policy for a company to put a man with a weak heart on electric line work or on a rigging gang where he would have to climb to great heights. The solution that offers itself, and that is being adopted in many plants, is the physical examination of workmen.

In the absence of L. A. Cole, who prepared a paper on "Stop and Non-Return Valves on Boilers and Engine Pipes," his paper was read by Mr. Sanborn. Mr. Cole mentioned the fact that many of our states and cities have adopted boiler inspection laws which apply only to the boilers themselves. He was of the opinion that rules should be applied to steam lines as well.

Boilers are often set where there is limited room. The same may be said of the steam pipes and stop valves. In such cases, if anything happens to the boiler, or if a fitting breaks, it is impossible to get the stop valves closed on the main steam line until all steam is off the entire plant. This loss of steam is very expensive to the plant owner. Just for this one reason, non-return valves should be installed to protect the boiler, but the law has nothing to say of the steam pipes and fittings in the plant as a whole. Protection of the boiler is all the law asks for, but the same protection should be given all steam pipe lines.

He is of the opinion that there should be automatic valves placed on all engine branches, and if the automatic valve is not used here, there should be a quick closing type of gate valve, with chain attached, and hung so as to be easily reached by the engineer or attendant. The automatic valve is best at this point, for a sudden flow of steam would close this particular line. But the question he wished discussed was, could one of these valves be so adjusted as to remain operative and not close if there should be a sudden demand of the engine for power?

In the discussion which followed, it seemed to be the prevailing opinion that non-return valves should be placed on all boilers, but it was not thought advisable to place on the boilers double disk valves, which would close the stop valve when a sudden rush of steam was demanded, as in many plants the demand for steam is excessive at times, and a closing of the stop valve would mean a great loss to the plant. Some of the instances mentioned were in the case of a blowing engine or in industrial plants where rolling mills are employed.

At the evening session held in the headquarters at the Hotel Secor, E. H. McFarland gave an illustrated talk on "Low and Medium Pressure Turbines, Construction, Installation and Test." A brief history of the development of turbines made by the General Electric Co. was given, and the features of design which have been the principal cause of the remarkable success of these turbines were pointed out.

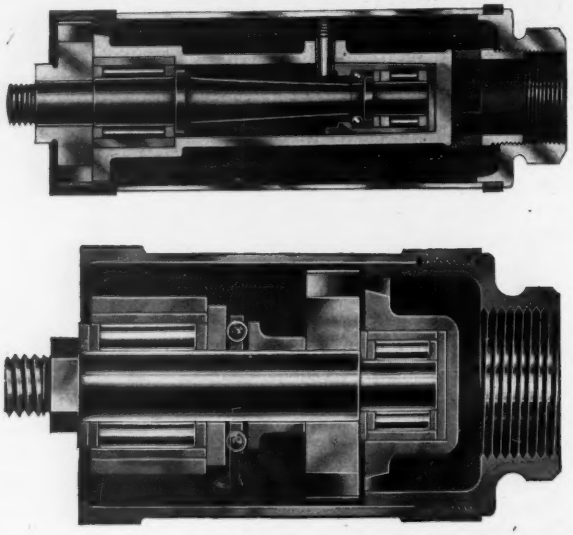
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Improved Roto Tube Cleaners

AFTER extended trials lasting over a period of nearly 2 yr., and having found that the use of ball and roller bearings in water-driven tube-cleaners enormously increases the speed, power, efficiency and durability of these machines, The Roto Co., of Hartford, Conn., has adopted this type of bearing on all its products.

It is claimed in many cases Roto motors, with this improvement, are cleaning tubes from 5 to 10 times faster than the solid or bush bearing motors heretofore used. The enormous friction and rapid wear of these steel-on-steel bearings have long been recognized as one of the



SECTIONAL VIEWS OF THE ROTO TUBE CLEANERS SHOWING BALL AND ROLLER BEARINGS

greatest difficulties with water-driven tube cleaners, and especially in those types of motors where the wheel is inside the motor, behind the bearing, with the result that the bearing is unavoidably flooded with water. It has been found that the friction in such motors is extremely high in proportion to the turning effort and that nearly all the power is absorbed in friction and little left for useful work. It can thus be easily realized how great the advantages are to be obtained by the use of roller and ball bearings.

Sectional views herewith show Roto tube cleaners employing ball bearings for the end load and roller bearings for the side loads. Many of these cleaners have now been in service more than a year under trying conditions, including very heavy service in many of the largest power plants, and it is said that not a single one of them has yet required any kind of repairs or overhauling, although in some cases they have replaced bush bearing motors in which the bearings were wearing out every few weeks.

Lytton Thermo Syphon Trap

THIS trap was especially designed to handle condensation under the various complicated conditions of pressure, vapor, and vacuum installations, one pipe layouts or any type of heating system, eliminating

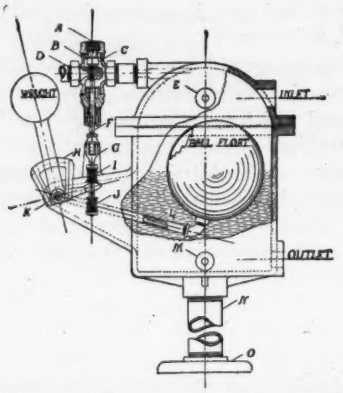


FIG. 1. SECTIONAL VIEW OF THERMO SYPHON TRAP

air, promoting circulation, and automatically discharging condensation direct into the boiler as rapidly as it accumulates.

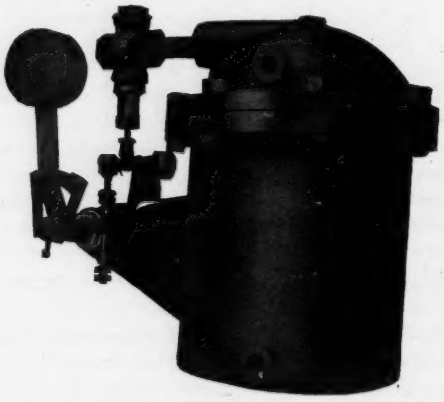


FIG. 2. EXTERIOR VIEW OF LYTTON THERMO SYPHON TRAP

The trap can also be used for draining heating systems and discharging the water to sewer or tank. If sufficient pressure is carried on the system, or live steam is available, the trap will lift the returns from radiators and

other drains that are located below the boiler water line, and discharge the condensate into another Thermo trap on top of boiler, which in turn may discharge into the boiler.

Prints are furnished showing piping arrangement and manner of applying the trap to the respective systems. The trap is connected up so that the bottom is 3 to 6 in. above the maximum boiler water line, requiring little head room. By inserting a piece of 2-in. pipe in the boss on bottom of trap and screwing an ordinary flange on the other end of pipe to act as a base, a strong and inexpensive floor stand can be quickly constructed by the pipe fitter.

The compound steam and vent valve is actuated by the rise and fall of the ball float, which moves weight rocker *H* and this in turn carries the weight to the right or left beyond a vertical position. When the float goes to the bottom of the trap the weight falls to the right and closes the steam valve and opens the vent, and when the float rises to the top the weight tumbles to the left and closes the relief *C* and opens the steam valve. Buffer springs *I* and *J* absorb the shock of these movements and render the operation noiseless. The float is always in direct communication with the atmosphere and any moisture that may sweat through the metal is ejected on each upward movement of the float through port *L*.

This trap is made in sizes with ¾-in., 1-in. and 1¼-in. steam connection having capacities of 1080, 2100 and 3600 lb. an hour respectively, by the Lytton Mfg. Corporation, of Franklin, Va.

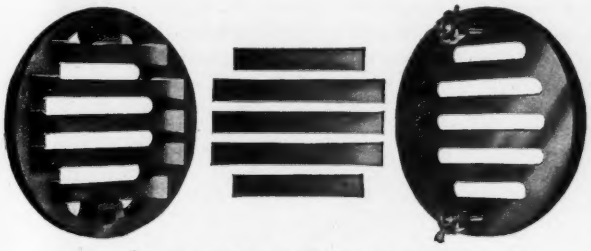


FIG. 1. PARTS OF LAIDLAW FEATHER VALVE

The Laidlaw Feather Valve

AFTER 4 yr. of experimental and development work for the perfection of a voluntary valve for use on air compressors, the Laidlaw-Dunn-Gordon plant of the International Steam Pump Co., has recently placed on the market the Laidlaw Feather valve.

This valve consists essentially of 3 elements, a ground face provided with slots, over which slots rest the valves proper, which are simply strips of thin, flexible ribbon steel similar to clock spring stock, though without any marked degree of temper. These valves are retained in their proper position, but not rigidly held at any point, by curved, milled guards, also provided with slots for the egress of air.

Three unique characteristics are possessed by these valves: 1st, the valve strips seat by contact, and not by impact, that is, the valve strip bends away from the side to permit the passage of air, rising in the middle but remaining in practical contact with the seat at the ends. Consequently, in reversal the valves instead of slamming bodily on the seat, simply meet the seat by increasing contact from the ends, giving an action entirely different from the sudden drop of the entire valve through even a low lift.

2nd: The valve strips being lighter and more flexible than can be used in any other construction, offer at the same time minimum resistance of both inertia and friction to the passage of air, a minimum destructive action in closing, and tightness after closing, due to the intimate contact with the ground seat permitted by the flexible character of the strip.

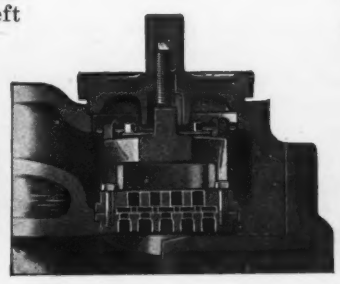


FIG. 2. SECTION THROUGH VALVE AS INSTALLED IN AIR COMPRESSOR

AIRSPRING GREASE CUP

3rd: The valve is not restricted in lift from considerations of noise and destructive action, and can be so designed as to permit opening through the lift equal to that through the seat, giving a combination of freedom of passage to air, quietness of operation and durability of action.

Airspring Grease Cup

FEEDING of grease to bearings is always somewhat of a problem, as the interval required between turning down the grease cups varies on different bearings, and keeping them all attended to properly is somewhat of a fussy task.

A relief from this necessity is offered by the Airspring automatic grease cup, made by the Hunter Pressed Steel Co., of Philadelphia, Pa., which feeds the grease automatically by compressed air, supplemented by a light spring. The air and spring are simultaneously put under compression by the normal adjustment of the cup, and give uniform and automatic feeding action to force the grease to the bearing, but do not, at any time, permit abnormal pressure upon the grease.

The cups are made from pressed steel, are filled in the ordinary way, and may be removed, cleaned and replaced just as conveniently as the ordinary style of cup. Cups are supplied in 4 sizes, ½-oz., 1-oz., 3-oz. and 6-oz., in plain and in polished steel, and for special uses may be had in brass and copper finish.

Anderson Separators and Water Column

WITH the growing practice of forcing boilers comes the increasing need of protection of engines from water. This protection is given by the Anderson steam separators, in which a series of spiral baffles gives to the steam a circular course, separating the water from the steam by the great difference in centrifugal force of the two. In the illustration is shown a phantom view of a vertical separator which brings out strongly the main features, showing the easy yet positive curves through which the steam passes, the substantial method of supporting the baffles, the large receiver space and the ring baffle which prevents water once separated from being caught up by the steam again. The same principles are employed in both vertical and horizontal types, but the forms are different.

Another Anderson product which is worthy of note is the safety water column, a sectional view of which is shown herewith. It has high and low water alarms, and insures a reliable method of giving warning when the water in the boiler to which it is attached falls below or rises above a fixed level.

When the column is in operation, the float rises until it comes in contact with the upper lever, causing the whistle valve to open, thus indicating the high water limit, or in case of low water, the float falls to a point where it comes in contact with the lower lever, when the whistle valve is again opened, indicating the low water limit.

The water gage can be attached to either side of the column, and a liberal sediment chamber takes care of all accumulated sediment.

The manufacturer of the above products is The V. D. Anderson Co., Cleveland, O.

Lunkenheimer Balanced Throttle Valve

FOR engine throttle purposes, a valve of exceptionally free and easy operation combined with efficiency is of necessity required. The accompanying illustration shows a valve designed with this important object in view. Its construction embraces all the essentials necessary for the highest type of engine throttle, and it is a most reliable valve of exceptional durability.

FIG. 1. ANDERSON VERTICAL STEAM SEPARATOR

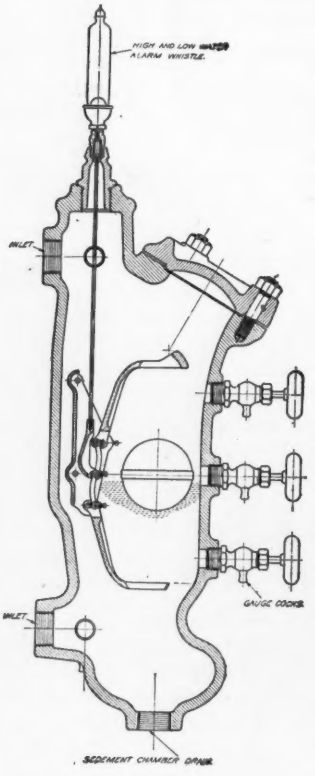
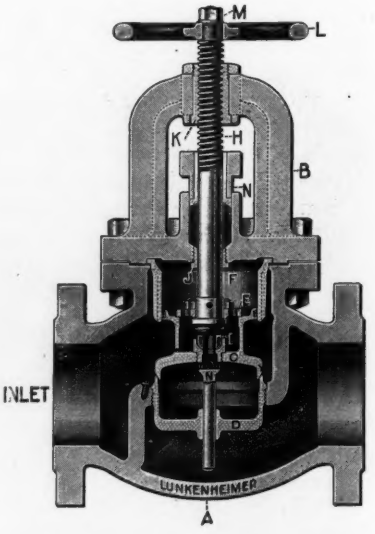


FIG. 2. SECTION THROUGH ANDERSON SAFETY WATER COLUMN



IMPROVED BALANCED THROTTLE VALVE

All the operating mechanism is assembled as a single unit in the removable hanger frame secured to the interior of the column casting by means of 4 brass screws. The float coming in contact with the upper and lower levers indicates the height of the water levels.

An important factor in the design of this valve lies in the simplicity of its design. There are practically but 3 moving parts—the main disc, bypass disc, and stem—and these being of large proportion, will safely withstand the hardest service to which valves of this type

are subjected. The ease of operation is directly attributed to the improved bypass construction, which equalizes the pressure on both sides of the disc.

The operation of the valve is as follows: Assume that the valve is closed and under pressure. As pressure will enter the balancing cylinder, by passing the piston ring and also entering through the small hole in the bottom of the disc cylinder, the pressure above the disc is equal to that in the inlet of the valve. This pressure aids materially in holding the disc C tightly to its seat; but unless some provision was made to relieve this pressure, the valve would be extremely difficult to open.

The method of relief lies in the bypass I, the opening through which is covered by the bottom of the stem H when the valve is closed. A slight turn of the handwheel, however, uncovers this opening and the steam above the piston will then pass through the holes in the retaining ring E, thence through the hole in the bypass disc I and holes in the main disc guide stem N, immediately relieving the pressure above the piston. Any pressure that may escape past the piston ring or through the small hole in the bottom of the disc cylinder, is also quickly relieved while the valve is being opened. As there is practically no pressure above the disc, the operation of opening the valve is therefore exceedingly easy.

Expansion or strains may slightly distort the seat; but owing to the annular extensions on both the seat and disc which provide spring seating surfaces they will regularly accommodate themselves to any slight irregularity, and therefore a tight valve is at all times assured.

The body may be tapped anywhere above the seat or inlet end for drain connection, so that any water from condensation can be removed before the valve is opened.

For the lubrication of the engine cylinder, the body can also be tapped on the inlet or outlet end, to which lubricator connection may be made.

This valve is made in sizes ranging from 4 to 10 in. inclusive. To suit various conditions of superheat and pressure and to meet the specifications of engineers who differ as to the materials used for the different parts, they are made in 6 combinations.

The manufacturer of this improved valve is The Lunkenheimer Co., of Cincinnati, Ohio.

Faultless Metallic Packing

ONE of the strongest features of this packing, which is made by the Hoyt Metal Co., 821 Chestnut St., St. Louis, Mo., is the simplicity and ease with which it can be applied to the rod. No alterations of stuffing-box are required, nor the removal of the crosshead. The metal used is a special mixture, and the rubber is especially prepared stock, which is not affected by oil, steam or ammonia. The rubber does not come in contact with the rod, as there is a continuous metal surface along the rod, and the rubber is used simply to give cushion, and a seal against steam leakage along the outside of the stuffing-box.

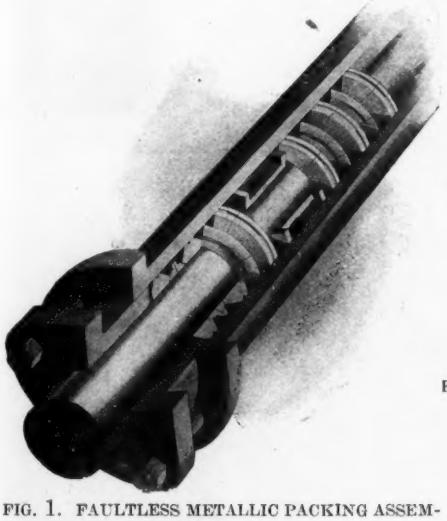


FIG. 1. FAULTLESS METALLIC PACKING ASSEMBLED ON ROD

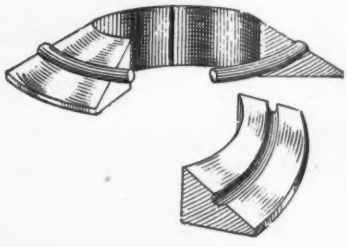


FIG. 2. METALLIC PACKING RING WITH ONE SECTION REMOVED

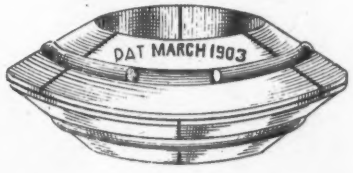


FIG. 3. PAIR OF METALLIC PACKING RINGS

The main object of the small hole in the bottom of the disc cylinder, is to drain water from condensation that may accumulate when the valve is connected in a vertical position, with the handwheel up. When in a horizontal position, any water in the disc and balancing cylinders will drain past the piston ring.

Both the main and the bypass disc are operated simultaneously by one movement of a single handwheel, which not only facilitates the quick operation of the valve, but insures the opening of the bypass valve at the proper time.

Provision is made for regrinding both the main and the bypass disc seating surface, should they become worn. As all parts are renewable, the durability of the valve is increased.

The packing consists of a series of metal rings, lathe turned to the diameter of the rod, with the gasket made conical in shape, and cut in 3 sections held together by a wire spring. The rings are used in pairs, with the flat sides together. The intermediate metal rings, with concave sides are simply to hold the metal rings to the rod, giving a ball and socket action, and the rubber rings on the outside, as already stated, are for sealing the outside of the stuffing-box. The illustration herewith shows the packing rings assembled, and a section view of the stuffing-box as filled for the piston rod on an ammonia compressor, having 2 sets of packing with an oil sleeve between. Further information can be had by addressing the Packing Department of the Hoyt Metal Co., 821 Chestnut St., St. Louis.

Simplex Emergency Jack

THE Simplex Emergency Jack has recently been placed upon the market as a tool of great usefulness and utility wherever there are loads to be lifted or pushed. It practically combines a crane and a jack. The accompanying illustration serves to show the jack acting as a crane in changing the location of a boiler, wherein pushing at an angle and lifting are necessary.

The standard or frame is a heavy malleable iron casting ribbed for stress in every direction. The circular bottom of the frame rests with a machine fit upon 2 circular shoulders, which are a part of the large, well proportioned base. In this way, the base takes the load and the steel pin acts to hold the frame in position. The base either holds the frame in a rigid vertical position or releases it to pivot on the base. Five feet of chain and a 5-ft. steel lever bar comprise the equipment.

The Simplex Emergency Jack is manufactured by Templeton, Kenly & Co., Ltd., Chicago, Ill.

JACK USED TO LIFT AND SHIFT BOILER

rack bar and cap are heavy drop forgings. The top of the cap is recessed for the chain, which is a part of the equipment. The double socket of crucible steel makes it possible to handle a load with the jack at any angle. A very heavy trunnion bearing supports the socket. The working angle of the jack is from 30 to 90 deg. to the horizontal. The trip at the back of the

Direct Connected Exciters

A SINGLE reservoir of power, to be drawn upon as required, was once believed by power plant designers to be the ultimate development of the central station. Carrying out this idea, all of the generators were to be connected to one bus-bar and would be excited from a central direct-current system. As central stations were, however, built in increasing capacities, the necessity for subdivision on account of excessive short-circuit currents became manifest.

Present tendency is to lay out the station as a number of independent units, so that trouble on part of the system will not cause a shut-down of feeders and apparatus other than those directly affected. Especially

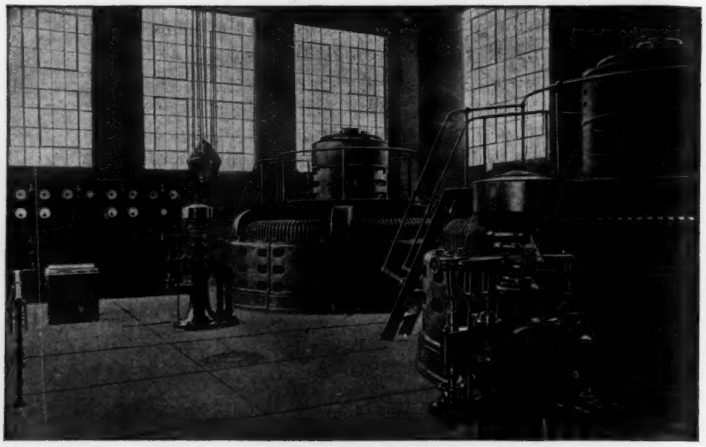


FIG. 1. EXCITER DIRECT CONNECTED TO VERTICAL ALTERNATOR

FIG. 2. DIRECT CONNECTED EXCITER USED IN CONNECTION WITH HORIZONTAL ALTERNATORS

is this trend noticeable in the case of hydroelectric plants where the power is used over a wide territory and must be delivered over long transmission lines which are particularly liable to trouble. To render each generator unit independent, many engineers now favor the use of individual exciters, each connected to its own generator.

The Westinghouse Electric & Manufacturing Co. has perfected a line of exciters especially adapted for such service. The chief point urged against direct-connection is that trouble in the exciter necessitates shutting down the generating unit unless leads are provided for exciting the generator from some other exciter unit. Hence reliability is the primary requirement in exciters designed for direct connection. Westinghouse designers have fully recognized this fact, and these exciters are characterized by rugged mechanical details and great overload capacity.

While these exciters are generally built especially for the particular generator to which they are to be attached, in the details of their design and construction they are similar to standard Westinghouse engine and belt-driven direct-current generators.

Several methods of mounting the exciter are employed. In the case of a vertical generator the exciter is carried by the thrust bearing bracket. With a horizontal generator, the exciter frame may be mounted on an extension of the generator bed plate, on a bracket attached to the bearing pedestal, or on a separate base.

Use of the direct-connected exciter has the following advantages: Each generator is dependent upon only its individual exciter, the number of plant auxiliaries is reduced, rheostat losses tend to be less, belts and belting troubles are eliminated, and a neat and compact appearance is secured.

The cost of the direct-connected exciter varies somewhat with the type of main generator with which it is to be used. This is due to the varying amount of excitation required by the alternator, which depends materially on its operating speed. A slow-speed unit will require more excitation than a higher-speed machine of otherwise similar characteristics, and the slower the exciter runs, the more expensive it will be. For this reason, direct connected exciters for engine-driven sets or slow-speed waterwheels make a more expensive layout than where the higher-speed waterwheel, belted, or turbo-driven generator is employed.

In addition to the advantages of greater freedom from trouble, etc., it is frequently true that an outfit of direct-connected exciters will be cheaper than any other arrangement. This is particularly the case in hydroelectric plants where other arrangements, affording equal independence, entail a much greater first cost.

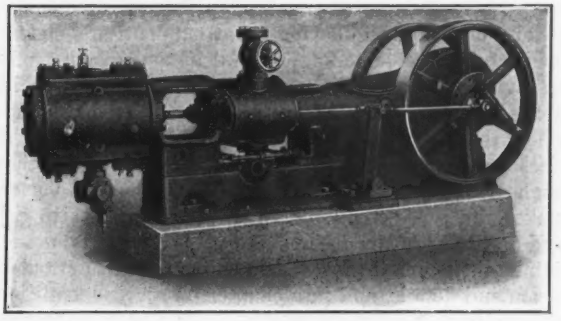
Small Air Compressor

THE small steam-driven high-speed air compressor illustrated herewith is a recent development of the Ingersoll-Rand Co., and is designed along the same lines as the company's former small steam-driven type, but embodies many improvements which give it a higher efficiency in the air end and a considerably lower steam consumption.

Ingersoll-Rogler air valves are now standard on the company's extensive line of steam, power and electric-driven compressors known as the "Ingersoll-Rogler" line. They allow of high speeds, give high compression efficiency, are almost silent in operation and are independent of any operating mechanism.

Balanced piston steam valves are used and permit of high speeds, high steam pressures and the use of superheated steam, at the same time giving a higher efficiency under ordinary low pressure steam conditions.

Automatic cutoff control gives the highest possible steam economy under conditions of varying load or varying steam pressures. This control is regulated by a centrifugal flywheel governor which acts to shorten or lengthen the stroke of the piston valve, thus changing the cutoff. Splash lubrication is employed, by means of which all wearing parts are copiously and automatically oiled.



INGERSOLL-ROGLER SMALL HIGH SPEED AIR COMPRESSOR

The machine as a whole is designed and constructed with a thoroughness as to detail which has long been a characteristic of this company's product. Materials are disposed with special attention to great rigidity without excess weight; bearing surfaces are large and carefully finished. Special provision has been made for ready adjustment of all parts.

The automatic cutoff control is supplemented by an air unloader, assuring great economy whilst possessing a high degree of automatism, which is essential in a small compressor designed for severe duty, and generally subject to considerable neglect.

Book Reviews

VOCATIONAL MATHEMATICS, by W. H. Dooley; Boston, 1915; 341 pages, illustrated.

While considerable attention is being paid to the teaching of mathematics in schools and colleges, it is found that the average student encounters great difficulty in the practical application of the theory he has been taught. Realizing this trouble, the author has, in the preparation of this volume, endeavored to give the student an insight into the practical application of mathematics to the everyday work of the carpenter, the metal worker, the electrician, etc.

Although primarily intended as a text book for the class room, being recommended by the author to take the place of first year algebra and first year geometry in vocational classes in which it is not desirable to give the

traditional course in algebra and geometry, this book will be found a great aid in the everyday work of the mechanic, electrician, steam engineer, etc.

Part I embodies a general review of arithmetic, while the following sections of the book take up the practical application of mathematics to carpentering and building, sheet metal work, machine parts, plumbing and hydraulics, steam engineering, electrical work, machine shop work and textile calculations.

The last 46 pages are devoted to an appendix containing trigonometric and logarithmic tables and formulas.

"Direct-Acting Steam Pumps," by Frank F. Nickel, 258 pages, illustrated; 1915, New York. Price, $3.

In presenting this book to the public, the author has recognized that scant attention has been given by writers on pumping machinery, to the direct-acting pump, and has taken up the subject in quite complete detail, starting with the history of the development of direct-acting steam pumps; and following this treatment, is a chapter on performance factors, a perusal of which will enable an engineer to calculate the various efficiencies, working heads, suction losses, capacities, etc., of steam pumps, when the proper data are known. In a chapter on classification of types, the author goes into quite thorough detail in regard to the construction of various makes and types of pumps, then explains the valve gear and operation of the designs now in the field. Pump end details then come in for a complete chapter, followed by steam end details, and in a chapter on service conditions vs. various types, the author gives his ideas in regard to the conditions under which the various types should be employed. In the closing chapters, duty, operation and adjustment of direct-acting pumps are taken up. The book as a whole is well written, and contains a great deal of information which is valuable to the operating engineer as well as the designer of power plants.

"A Study of Boiler Losses," by A. P. Kratz, has been issued as Bulletin No. 78 of the Engineering Experiment Station of the University of Illinois. This bulletin presents a critical analysis of the data taken from a series of 25 trials made on a 500-hp. Babcock and Wilcox boiler in the University heating plant.

The heat balance has been subdivided so as to isolate and determine the amounts of the several losses chargeable to the boiler, furnace, and setting. Complete forms for calculating a series of boiler trials are also given.

Tests were made also upon some samples of weathered coal. No difficulty was experienced in burning this coal, but it was found that it had deteriorated during the weathering until it was about the same composition and grade as fresh Vermilion County screenings.

Copies of Bulletin No. 78 may be obtained gratis upon application to C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

Resuscitation, by Charles A. Lauffer, 90 pages, illustrated; New York, 1915. Price, 50 cents.

Anatomical details of the Prone Pressure (or Schaefer) method of resuscitation from electric shock, traumatic shock, drowning, asphyxiation from any cause, are given in this book, with complete directions for self instruction. It also contains a discussion of experiments with commercial devices for artificial respiration, and several harmful factors brought out by these experiments. Brief notes have been added on instances, that have come under the author's observation, of success in the use of the Prone Pressure method.

Combined Power and Heating Plants, by Chas. L. Hubbard, 1915; 408 pages, 6 by 9, illustrated. Price, $3.

In this book, the subjects covered relate especially to the power and heating equipment in buildings of large size, such as office buildings, department stores, municipal buildings, hotels, hospitals and institutions, theaters, technical and trade schools, loft buildings, railroad stations, machine shops, binderies, paper and textile mills.

It has been the aim of the author to treat the various problems somewhat broadly and with special reference to steam equipment. Equipment relating to the use and generation of steam has been considered in some detail while other matters, such as lighting, elevator service, refrigeration, etc., have only been touched upon as they relate to the steam side of the problem. It has been assumed that the reader is already familiar with the usual details of heating and ventilating designs, hence attention has only been given to the special requirements of the buildings under consideration. In the later chapters, a study has been made of the relation between power and heating and methods given for determining the results to be expected by combining the two in a single plant under varying conditions. The book gives a comprehensive view of the problems of this kind and enables one to decide upon the best system of heating to employ, also to determine what advantages, if any, may be gained by generating power upon the premises and what type and arrangement of power equipment will be best fitted to meet the especial requirements.

Two chapters of especial interest are devoted to working data for steam and hot water heating, and hot blast heating and ventilation. In these chapters are given formulas, tables, etc., which enable the engineer to calculate the requirements in these systems. In another chapter power and steam requirements for different types of buildings are discussed, giving the reader a comprehensive idea of the needs of various types of buildings which may be supplied from the power plant. The last 2 chapters deal with equipment and operating costs and practical examples and design and cost of operation.

The author has covered the subject as completely as could be expected in the space which has been used, and the various topics are written in clear and concise language, without resorting to mathematics except in calculations, and here the methods employed are the most simple to reach the desired ends.

Model T Ford Car, its Construction, Operation and Repair, by Victor W. Page, 300 pages, 5 by 7 in., 100 diagrams and halftones, 2 folding plates, cloth bound, $1.

This new book is full of complete and practical instruction on the details, the care and the handling of the Ford car. All parts are shown by illustrations and fully described, so that in making any repair, or doing any work about the car, the reader is fully informed before he begins as to just the construction which he

will meet as he goes along. It is written in such a way that drivers and owners who are not technical experts can understand it and do the work desired on their cars, but is so complete that even the most technical man can find much of advantage in it.

It is divided into chapters on the construction of the car, engine and auxiliary groups, details of chassis, how to drive and care for the car, overhauling and repairing. The writer is a man who has for years driven and repaired these cars, and writes from actual knowledge of what he is talking about.

Catalog Notes

FROM THE Uniform Electric Rate Association, whose address is Box 894, Toledo, O., have come 2 interesting booklets, one on Electric Rates, by P. R. Moses, and one on Central Power Station Rates, by L. D. Brandeis. The Association has been organized to agitate for schedules of Public Service Rates for electric current based on the principle of "cost of service" to each class or group of consumers. The rates may vary in amount if they are consistently based on cost of service. The Association claims that analyses of schedules show that charges and collections from small customers now cover substantially all the net profits in the operation of the Public Service Companies, whereas the difference in the cost of serving a group of small customers is not materially greater than of serving one large customer with the same quantity and at the same time.

The Association condemns the method of basing rates on the "value of service to the customer" as determined by the amount for which the user could supply himself, in other words, "what the traffic will bear." The public service corporation which sells current is subject to state regulation in the same manner and for the same reason as steam railroads.

The booklet by Mr. Moses gives an analysis of the elements entering into cost of service, giving the factors which enter into such cost as production, transmission, storage, distribution, utilization, selling, general executive, overhead, depreciation, and discussing each in detail. From his analysis, Mr. Moses concludes that "It appears, therefore, that . . . no difference exists in operating (production) cost between retail and wholesale users." Hence, also, that there should be no difference in rate charged for residence and for business purposes. No difference in rate for power or lighting current used at the same periods. A justifiable difference between rates for short period and long period based on expense for interest, taxes, and amortization, and divided into a Peak Load Demand charge and a Consumption charge. This would be accomplished without appreciable inequity by a flat rate to all users, for residence or business, for light or power, except long-hour off-peak users; no difference should be made in rate on account of quantity used. There is, of course, a chance for difference of opinion on these points; but Mr. Moses gives in the booklet the basis for his conclusions, so that every reader can think it out for himself.

In the pamphlet by Mr. Brandeis definite questions are asked and answered as to the right of a Public Service Corporation to charge different rates for light and power or for large and small quantities, if the cost of producing and delivering the current is the same for all; also, if there is a difference in cost of producing and delivering, whether the difference in rate may be made greater than this difference in cost.

Mr. Brandeis states that these questions have not been authoritatively decided by the courts, but the principles are definitely established. Quoting from decisions on railroad rates, and on rates for gas supply, he concludes that: "Assuming that the cost of producing and delivering electric energy is the same per unit regardless of quantity supplied, . . . a public service corporation cannot legally charge a lower rate for a larger than for a smaller quantity delivered at the same time and under similar conditions."

If cost of production and distribution is greater for retail than for wholesale users, the corporation can, in the absence of statute regulation, "make a higher price to the retail customer, but the difference in the selling price may not be substantially greater than the difference in cost."

As to difference in rate according to purpose for which current is used, there is more doubt; but the weight of authority "seems opposed to permitting any discrimination." Difference between day use and evening use "seems a proper basis of classification of service," but "It seems clear that mere difference in the value of the service or its character to the user does not afford any justification for discrimination as to rates."

Both booklets are valuable contributions to the discussion on the very live question of how, and how far, regulation of Public Service Companies shall be carried either by law or by Commissions.

SPARK PLUGS and How to Make Them Give Perfect Service is the title of an instructive booklet just issued and which will be sent free by L. F. Benton Co., Vergennes, Vt. This booklet is intended primarily to help dealers who sell Benton spark plugs, but is also filled with advice on keeping plugs of every type in best working condition.

THE WEBER CHIMNEY CO., 1452-56 McCormick Bldg., Chicago, is sending out its catalog for 1915, illustrating its chimneys and showing list of users numbering nearly 1000 throughout the U. S. and other countries. A copy will be furnished, with other literature in reference to concrete chimneys, to anyone interested.

SMALL MOTORS No. 23, recently received from Westinghouse Elec. & Mfg. Co., describes and illustrates the company's Type CA single-phase motors, which are of the split-phase type without sliding contacts, and are interchangeable as to mounting with Type CD direct-current motors.

ELECTRIC HOUSEHOLD APPLIANCES, most of which may be connected to the ordinary lighting circuit, are illustrated in one of General Electric Co.'s latest circulars.

"SAFETY FIRST" is the title of a pamphlet issued by the Youngstown Sheet & Tube Co., of Youngstown, O., and it is notable that, in all the work carried on by this company for the safety and welfare of its employes, the advertising value of the proposition is given but little attention. The entire effort is to institute such safeguards and conditions as will cut down to the minimum

the accidents which ordinarily would occur around one of the biggest steel plants in the country. The result has been that accidents and loss of life have been reduced, and the confidence and co-operation of employes have been secured. The pamphlet shows numerous signs and devices which have been installed in the works for the purpose of preventing accidents, and insuring good health and welfare.

BULLETIN NO. 42,552, entitled Motor-Generator Sets, has just been issued by the General Electric Co., and is an attractive publication of 28 pages, inclosed in a designed cover and containing numerous illustrations of various types of motor-generator sets designed and manufactured by that company. There is included a general description of this type of apparatus.

METERING AND RECORDING boiler feed water is discussed in Hoppes Mfg. Co.'s catalog in reference to the Hoppes V-notch meter recorder and integrator. Illustrations show the meter and recorder used in connection with a feed water heater, sectional view of Hoppes recorder head, etc. New features incorporated

in the meter are described and the construction of the recording and integrating device is explained, also the erecting of Hoppes V-notch meters and weigher recorders.

"ADSCO" WATER HEATERS made by American District Steam Co., No. Tonawanda, N. Y., are described, with table of sizes, capacities, dimensions, weights, and list prices, in a circular lately received.

FROM SMOOTH-ON MFG. CO., Jersey City, N. J., comes a circular illustrating a swimming pool waterproofed with Smooth-On Iron Cement. The company will be pleased to send one of these circulars to anyone sending name and address.

A CIRCULAR relating to American flexible metal hose and tubing has just been received from The American Metal Hose Co., Waterbury, Conn.

PUT YOUR BOILERS on a Plane with the Central Station is the title of a new folder from Dearborn Chemical Co., McCormick Bldg., Chicago.

THE ANDERSON pressure oil filter, manufactured by The V. D. Anderson Co., Cleveland, O., is described in a recent bulletin which also illustrates the interior construction and various arrangements of the filter, discussing installation and operation.

A NEW COMPOSITION disc, No. 119, to be used in all Jenkins Bros. Standard Pattern globe, angle, cross and radiator valves, when intended for steam service, is described in a circular just received from Jenkins Bros., 80 White St., New York.

Trade Notes

THE TERRY STEAM TURBINE CO., Hartford, Conn., announces the appointment of Joseph Battles as District Sales Manager for Denver, covering the States of New Mexico, Colorado, Wyoming, and the western portion of Nebraska. Mr. Battles' address is 326 First National Bank Bldg., Denver, Colo.

BURGESS & LONG, Consulting Chemical Engineers, Columbus, O., have added to their staff an expert combustion engineer, who has had long and thorough experience in the testing and practical operation of power plants, and who is familiar with the various types of equipment, both new and old, used in boiler rooms. With the addition of this engineer, this firm is now in position to make an examination of power plants and give expert advice in regard to operation and equipment.

IN ITS MECHANICAL DEPT., Goodyear Tire & Rubber Co., of Akron, O., has found the demand for all kinds of rubber hose phenomenal, partly in the field of regular brands, because of the dry weather in April, partly for the Kantkink hose, which is used extensively in shops, mines and garages. Also, the demand for gasoline hose has been active, and the company has produced a brand which will successfully resist the action of gasoline and, at the same time, will not discolor the fluid.

ON JUNE 1, Ingersoll-Rand Co., 11 Broadway, New York, opened its branch office in San Francisco at 139 Townsend St., with a view to giving closer attention to present and prospective users of Ingersoll-Rand machinery than it is possible for any agency to do. Harron, Rickard & McCone have been efficient agents of the company and arrangements have been made whereby they co-operate in the sale of Ingersoll-Rand machinery after the expiration of their agency contract of July 22. H. L. Terwilliger will be District Manager for the territory handled by the San Francisco and Los Angeles offices, with headquarters in San Francisco.

THE DIESEL TYPE engine, manufactured by the McIntosh & Seymour Corporation of Auburn, N. Y., will in future be sold in the Texas and Oklahoma territory through the agency of Arthur G. Wright, 209 Slaughter Bldg., Dallas, Texas. This appointment excludes that portion of Texas west of a line drawn north and south through Del Rio.

Mr. Wright, who will now be handling exclusively the McIntosh & Seymour engines and Goulds pumps, is well acquainted with the Diesel engine business in the South, having been sales engineer with the H. W. Graber Mchy. Co., who were Southwestern agents for the American Diesel Engine Co. In succession to that work Mr. Wright was connected for a long period, as Western sales manager, with a firm handling boilers, steam engines, generators, etc. In 1912 he become vice president of a company which acted as jobbers of machinery and mill supplies. His extensive experience with machinery business and particularly with all types of power plants, renders him a valuable consultant to those who are considering new installations, and his advice may be sought by all parties interested.

RAPID AND CONSISTENT growth of its business has caused the Graphite Lubricating Co., of Bound Brook, N. J., to add to its present plant, which covers a city block, another plant, to be devoted to the manufacture of Nigrum treated wood oilless bearings exclusively. This plant occupies 2 acres of land, and is located at Lincoln, N. J., 2 miles east of Bound Brook. The addition of this plant will release space in the main plant for greater facilities in the manufacture of Bound Brook graphite, and bronze oilless bearings, permitting of greater output and absolutely prompt service. These Bound Brook bearings have been used for 25 yr. on cranes, engines, mill machinery, tools and battleships, are made for shaft journals, collars and combined journal and thrust.

The Nigrum oilless wood bearings are comparatively new, as they have been on the market for 2 yr., after 8 yr. of experiment and testing. The new Nigrum department has expanded rapidly and has demanded the acquirement of the new plant. This is located on the main line to New York, with branch tracks from the Central R. R. of N. J., the P. & R., and the B. & O. Two buildings are at present erected, one 30 by 130 ft., for machinery to finish bearings to shape; a second of 2 stories 40 by 120 ft., of which the first story is occupied by the impregnating room and the second by office and stock room.

DISCUSSING THE QUALITIES and popularity of Goodyear Everlast sheet packing, I. R. Bailey, Manager of the Mechanical Goods Department of the Goodyear Tire & Rubber Co., Akron, O., states that European countries must be acknowledged as slightly in advance of America in manufacturing compressed sheet for high pressure work, such as superheated steam, joints for gasoline engines, etc., but the demand has increased to a point where this type of sheet packing is rapidly supplanting high pressure gum sheets, and several American manufacturers have entered the field to furnish compressed sheet.

Over 2 yr. ago, the Goodyear Co. equipped a plant in accordance with the ideas of an experienced man who had received training abroad, and began the manufacture of a high grade compressed sheet, which ranks high in the matter of tensile and service tests, is sold at a fair price, and as a consequence, keeps the plant running day and night. Arrangements have recently been made to treble the output of the Everlast compressed sheet.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

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About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As assistant engineer, experienced; I. C. S. student; best references; strictly sober, hold first class license; will consider small salary if advanced as merited. Address Robert Pieper, Bloomington Prairie, Minn. 6-15-2

POSITION WANTED—By young man, age 21, as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 7-1-1

POSITION WANTED—By engineer in medium sized power plant or helper in large one. Have third class Ohio License. 5 years' experience with steam engine and boilers. Some experience with electricity. Good habits. Sober. 25 years old. Good reference. Address Emmett R. Ralston, Box 43, Cheshire, Ohio. 7-1-1

POSITION WANTED—As chef engineer in a small or medium sized plant. Twelve years' practical and technical experience in operation and maintenance of steam, electric refrigerating, pumping and condensing equipment. First class license. Married; age 30. Employed. Address Practical Engineer, Box 392, Chicago, Ill. 7-1-1

POSITION WANTED—Man 39 years old, long experience with electric light and water works plants. Five years manager on plant. Strictly sober. Best references. Wants position as manager plant. Texas or Oklahoma preferred. Address C. X., 809 Austin Ave., Brownwood, Texas. 7-1-1

POSITION WANTED By engineer in medium sized power plant, or large coal mine. Have Illinois license; 7 years' experience with steam engines and boilers. Some experience with electricity. Good habits. References. 24. Illinois preferred. Address W. E. Rohline, Box 224, Farmington, Ill. 7-1-1

POSITION WANTED—Steam engineer wants position in water works or mill plant 33 yr. old. Married. Sober. Best of references. Iowa preferred. Address F. J. Kirkpatrick, Indianola, Iowa. 6-1-2

POSITION WANTED—By engineer, 8 yr. experience with steam and electric. Understand gas engines and refrigeration. Temperate, reliable, married man. Member N. A. S. E. Address W. H. Snyder, 53 Brown St., Hartford, Conn. 6-15-2

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references. Ezra D. Dumas, Clarinda, Iowa. 6-1-2

POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineers license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 6-1-3

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 6-1-2

POSITION WANTED—As assistant in power house. I. C. S. student. References. Sober. Will consider small salary if advanced as to merits. Address Fred Lamb, Box 15, Longmont, Colo. 6-15-2

Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

AGENCIES WANTED—The Eckel Hydrostat Co., 460 Mt. Elliott Ave., Detroit, Mich., desires steam specialties for their agents in lower Michigan. 7-1-2

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried, and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FANS AND MOTORS—For sale a large number of A.C. and D.C. electric fans, new and at prices from $6.00 each upwards. All styles, including oscillating, ceiling, desk, etc. Motors alternating 1/12 to 7½ H.P., one, two, and three phase. Motors, direct current 1/40 to 30 H.P. for all voltages. Generators also. Fidelity Electric Co., Lancaster, Pa. 6-1-4

FOR SALE—(3 or 2 phase, 60 cycle, 220 volt alternators), 150 K. V. A. Westinghouse late type, 900 RPM., $750. 125 K. V. A. General Electric type ATB., 900 RPM., $750. 100 K. V. A. Fairbanks type RF, 900 RPM., $550. 75 K. V. A. Bullock type RF, 1200 RPM., $550. 175 K. V. A. General Electric generator, dir. con. Atlas 4 valve engine, $1850. Duzets & Son, 50 Church St., New York, N. Y. tf.

FOR SALE—Grobet Swiss Files are the standard of excellence in files, and have been for over 100 yr. We send, post paid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. 7-1-1

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patnet can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington D. C. tf.

A. P. CONNOR, consulting electrical and mechanical engineer, attorney-at-law and solicitor of patents and trade-marks, 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own), to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineerng Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Inventions

INVENTIONS WANTED—Cash or royalty paid if available. Adam Fisher Mfg. Co., D175, St. Louis, Mo.

Sparks From The Advertising Pages

Extracts From Address of John H. Fahey, President of the Chamber of Commerce

of the United States at the Annual Convention of the Associated Advertising Clubs of the World. Chicago, June 24, 1915.

"Advertising and Commercial Organizations as Allied Forces in the Promotion of American Business."

If there are still extant men who ask the question "Does it pay to advertise," I know their thinking is of the kind which would lead them to light factories with candles and insist upon the advantages which would accrue if the residents of modern cities still drew their water supply by bucket from the town well.

When nations in the greatest struggle of history advertise for armies; when kings and emperors and sultans come down from their thrones to seek the attention of the world and present their pleas and defenses through the press; when it has become the daily bread of a large part of the world's business, it is indeed a man of limited mentality who still questions the power of publicity. Its value to society has in fact so impressed itself that today publicity is the light of the world. It may be said, with little element of speculation in the assertion, that if publicity had characterized dealings between the nations of Europe during the past 50 years, and secret diplomacy had been eliminated, the present world war, with its terrorism and threat to all civilization, would not now be raging.

The power by which hundreds of thousands of minds, yes, millions of minds, may be turned to consideration of the same thing at the same time, is a wonderfully useful influence. Whether that power is employed to make millions think of the policies of the government or the homely comforts and economies affecting their daily lives, the underlying value of this power is the same; the advantages to be gained from its use are identical.

It is often contended that you cannot advertise successfully when business is bad, but the extent to which confidence may be restored and enthusiasm reawakened by enterprising advertisers under adverse conditions was demonstrated again and in remarkable ways during the period of uncertainty which prevailed in our own country immediately after the first of last August. Once more it has been shown that the public demand for commodities always exists in greater or lesser degree. It is simply a question of brains and ingenuity in securing response under conditions a little harder than usual.

The war emphasizes old difficulties and brings with it new conditions. Whether we are brought into it directly or not, and surely we all of us pray that we shall not be,—it is bound to mark an epoch in the evolution of this country. In the first place, it is stimulating us to think nationally as we never have before. In the second place, it is setting our thinking processes at work concerning international questions and the world as a whole. We re beginning to understand that every part of this country is bound up in the prosperity of every other part, that every citizen in it is interested and concerned in justice and happiness and prosperity for every other citizen, whether of high or low degree.

* * *

If thoughts of destruction and terror and hate can be made to dominate the minds of a people by any propaganda, surely the ambitions of an entire nation may be turned to construction and the spread of happiness, if sufficient effort is employed.

There is nothing impractical or fantastic in the suggestion that the United States should be an example to the world in its ability to solve its social and economic questions. Steps toward the attainment of that end are being taken every day, but many of them have been painfully halting and slow. I would emphasize the fact that we must now move more surely and more rapidly, particularly in settling those very practical business questions which so closely affect national prosperity. Many of these have been with us for years. We have been extremely neglectful as citizens in permitting them to become sharply political in character when they were, in fact, economic and their solution was not a question of party alignment.

For example, how much longer should we go on making tariffs, from time to time, by the log rolling methods that have obtained in the past, bringing to the country periodical uncertainty and trouble during the period of discussion and adjustment? Is it not time that we took heed of the best practice in the world and established a non-partisan tariff commission on the basis of whose investigations just

and fair tariffs might be fixed? Is the establishment of such a system a matter of partisan politics? Is it not something which concerns us all, and is it not time public opinion demanded that the leaders of all parties agreed upon an equitable system?

* * *

There is no power in citizenship which can be more useful to the nation, if exercised wisely, fairly and intelligently, than the business men working together in all parts of this country without partisanship and without prejudice for its general upbuilding. It is for this reason that I would direct your attention to the very significant movement which has swept over the United States during the last dozen years and reformed our local and national organizations of business men, finally uniting them in the federation known as the Chamber of Commerce of the United States.

As you well know, the Chamber of Commerce, the Board of Trade or the Commercial Club has always been accepted as a more or less necessary institution in every community. It pretended to represent interest on the part of the business men in general community progress and, in a remote way, in national development. Sometimes it fulfilled this function rather well, but more often it was narrow in its vision, and the value of its accomplishments was rather uncertain. What was true of the single community was likewise true of most of the national trade organizations. The truth is that until within ten years we have been so far behind European countries in the character and efficiency of our organizations of business men that there was no comparison, and because of this condition we were sadly lacking in a factor which has been of enormous importance in the growth of progressive countries abroad. Even here at home we could not fail to observe the strides made by the agricultural interests and the labor interests as a result of organized effort, while business representing so large an element in national success lagged behind.

But within the period of which I speak, great change began in a number of important cities. Business men became impatient of the conditions affecting their organizations and began a general overhauling. The idea spread from one city to another until today the local Chamber of Commerce which is not worthy of respect and which is not strenuously doing its share in local development and in stimulating national interest, is the exception rather than the rule. Out of this wholesome regeneration came the demand for national federation and the foundation of the Chamber of Commerce of the United States following a confidence on the part of representatives of all the organizations called by President Taft in Washington three years ago. With such speed has the idea developed that the Chamber today includes in its membership nearly 700 organizations in every state in the union. It maintains an efficient headquarters in Washington and branch offices in New York, Chicago, San Francisco and Boston. Its membership, all told, now represents about 350,000 firms, corporations and business men, and it has become the largest association of its kind in the world.

Its first duty is to crystalize the sentiment of the business men of this country on great national questions, such as those to which I have referred. It must do this without bias or partisanship after thorough investigation and the most careful consideration. In determining these issues, in fixing the policies of the Chamber, every organization in the country, large and small, has its voice. Everything it does is in the open, available for criticism by all men. There can be nothing concealed. It cannot be used by any clique or group. It must be thoroughly American and broadly patriotic in everything that it does. Aside from bringing the business view point to bear upon great public questions, it must work with the government in extending the use of the facilites which the government now provides for the promotion of business. Until now, the business men of this country have had little knowledge of the things being done by government of value to business, if they were only utilized. It is an important responsibility of this organization to bring that fact home to business men and to aid the govment in the betterment of existing machinery.

* * *

You of the world of advertising are a part of business, and an important one. I have said that the responsibilities of leadership in business thought lie especially upon you, because in your daily lives yours is the art of influencing the human mind, of stimulating mental processes in common with all other kinds of business men, as well as other classes among our citizens.

A large part of the world is rent asunder today by a great conflict in which men and women are giving all they have in the world, even their lives, in response to the call of country. In many a family in Europe, all the sons have gone to death within a few months, while the daughters also daily expose themselves to danger in work among the sick and wounded. Yet all this heartbreaking sorrow and hardship is accepted with resignation, on the premise that it is necessary for the common good. With such examples of sacrifice and patriotism before us thrilling the world from day to day, should we of America be any less responsive to the call of country when our opportunity for service involves only good citizenship in our daily lives?